THE DANISH INGOLF-EXPEDITION.

VOLUME IV.

1.

ECHINOIDEA.

(PART I.)

BY

TH. MORTENSEN.

WITH 21 PLATES AND 12 FIGURES IN THE TEXT.

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I.

By

Th. Mortensen.

The present work forms the first part of a planned revision comprising all the arctic Echinoderms, excepting the Holothurioidea. The basis of the work is formed by the rich material of the Ingolf-Expedition together with the large collections of arctic Echinoderms found at our Zoological Museum from earlier expeditions. To the arctic fauna all the species are referred which are found in the Norwegian Sea, the Greenland Sea, the Denmark Strait, and at the coast of West-Greenland, as also in the White Sea and the Polar Sea with the Bering Strait. Of forms that are only found south of the large ridge between Greenland and Iceland, and between Iceland and the Faröe Islands, only such as have been taken by the Ingolf-Expedition, have been included in the work.

During the examination of the material the absolute necessity of taking into consideration also other more or less nearly related forms soon made itself felt. By and by I became aware of the fact that the classification hitherto used with regard to the families treated of here, was quite erroneous, and so I have sought to include into the examination as many forms as possible in order to be able to give the new classification that had to be made, so broad a base as possible. Inspector G. M. R. Levinsen placed the whole rich collection of Echinoids of the museum at my disposal with the greatest readiness; but as far from all species and genera are represented in this collection, I have applied to several foreign naturalists, and have everywhere been met with the most obliging kindness and friendliness, so that I have been enabled to examine almost all known genera and species comprised in the groups treated of here.

The following gentlemen have sent me Echinoids on loan or in exchange: Dr. Appellöf (the Museum of Bergen), Prof. F. Jeffr. Bell (British Museum), Prof. E. v. Beneden (Liège), Prof. Collett (Christiania), Prof. Döderlein (Strassburg), Conservator J. Grieg (the Museum of Bergen), Prof. Koehler (Lyons), Prof. P. de Loriol (Genève), Prof. E. v. Marenzeller (Vienna), Geh.rath, Prof. E. v. Martens (Berlin), Geh.rath, Prof. K. Mobius (Berlin), Prof. Monticelli (Naples), Prof. P. Pallary (Oran), Prof. G. Pfeffer (Hamburg), Prof. R. Rathbun (U. S. National Museum), Prof.

d'Arcy Thompson (Dundee). By this present I beg to offer my sincerest thanks to all these gentlemen. Finally I had occasion for a short stay at the British Museum in August 1901. By the genial friendliness of Prof. Bell I was enabled to examine a great many forms, especially original specimens from the Challenger-Expedition. It will appear throughout my work, that this stay has been of material importance to me, and my best thanks are due to Prof. Bell for his liberality. Still I have to thank Dr. F. A. Bather (British Museum) for his excellent assistance in several literary questions.

Copenhagen, January 1902.

The Author.

Loin d'être nuisible aux vrais progrès de la science, cette multiplication des genres, lorsqu'ils sont établis sur des caractères précis, ne saurait avoir d'autre effet que de rapprocher de plus en plus les espèces, que leurs caractères naturels lient le plus étroitement. C'est là le grand avantage des petits genres, et cet avantage est surtout sensible dans les familles, dont toutes les espèces se ressemblent par leur aspect extérieur et par l'ensemble de leurs caractères.

L. Agassiz.

On generic and specific Characters in the Echinoids.

Everybody who has studied Echinoids, will have felt a considerable difficulty in recognising many of the genera, at all events of the regular Echinoids. Such was, at any rate, my case at the commencement of my researches. I studied the excellent collection of these animals found in our museum, and found it to be more and more hopeless. A great many genera were exhibited, as: *Echinus*, *Psammechinus*, *Toxopneustes*, *Hipponoë*, *Boletia*, *Psilechinus*, *Lytechinus*, *Loxechinus*, etc.; but it seemed to be impossible to discover the characters on which they were established, whether the naked tests, or specimens that had kept the spines, were examined. And the literature did not contribute very much to clear up the question. To be sure, some of these names (— as it will be seen, partly unjustly —) appeared to be synonyms; but nevertheless the other genera were not much better characterized. We learned through long descriptions that the spines were thick or thin, few and scattered, or many and closely packed; that the tubercles might be small or large, and that they might be placed in more or less regular series, etc. — altogether things easily enough seen, but so relative, that it was impossible to get any any firm hold. It was almost enough to drive one to despair.

Still a faint hope was left. Might not the difficulty be in the literature, and the animals themselves in reality be less intractable? A profound and careful attempt at penetrating into the mysteries of the relationship of the Echinoids was planned, and the plan was the simple, but clear one: to let literature alone for the present, while the animals were studied thoroughly. Everything had to be examined that might in any way be supposed to show systematic characters: the test, the spines, the tube-feet, the pedicellariæ, the spicules, the sphæridiæ, etc. The beginning was to be made with the *Echinus*-species. This choice seemed to be the best one, as these species have hitherto been especially notorious for their difficulty, and a very rich material of them is found in the museum of Copenhagen. The result was excellent. The animals proved to be very tractable, the species to be very well characterized (with a few exceptions). The difficulties arise from the literature containing numberless bad descriptions. And what a confusion is reigning in the literature with regard to the names. Almost every species must drag along with it a lot of synonyms, not only specific synonyms, but also generic ones. Several species have by and by been referred to a whole series of different genera, to end at last as a separate genus, as badly characterized as most of the other genera. To name only one instance: The genuine *Psammechinus*-species: *variegatus* (Lamk.) and *semituberculatus* (Val.) have by and by been referred to the following genera: *Echinus*, *Lytechinus*, *Schizechinus*, *Toxopneustes*, but only rarely, in recent times not at all, to the genus to which they decidedly belong. On the other hand the following extraneous species have been referred to *Psammechinus*: *Echinus norvegicus*, *magellanicus*, *miliaris*, *microtuberculatus*, *angulosus*, *Strongylocentrotus Gaimardi*, *intermedius*,

Sphærechinus pulcherrimus, *Evechinus chloroticus*, *Echinostrephus molare*. — This instance may be taken as a significant illustration of the generic descriptions. Or should it be necessary also to recall the genera of Cidarids?

That under such circumstances erroneous determinations have been frequent, is not to be wondered at. I have had occasion to substantiate several (far too many!) cases, and such cases too where the greatest authorities have been responsible for the determination. We ought therefore to be very cautious in using the existing statements with regard to the geographical distribution of these forms.

The characters that have hitherto chiefly been used for the distinguishing between the genera and species, are the following: the pores, the spines, the tubercles, the mouth-slits, the lining of the buccal membrane with larger or smaller plates, and the calycinal area. All these structures may give excellent characters, and, of course, they are always to be taken into consideration. But most frequently they are so relative, that it is exceedingly difficult or impossible by means of these structures to decide whether a specimen in hand belongs to one species or another. Such is especially the case when the question is of the position of the tubercles; it may be simply irritating to read the descriptions of these in different species that are to be compared, and often the result falls very short of the exertion to get a clear view of the descriptions. To this may be added that the number, size, and position of the tubercles vary very much with age. With regard to the pores, their number and mutual position is no absolutely reliable character either. That in species with many pairs of pores their number increases with age is a well-known fact. The young *Strongylocentrotus drobachiensis* has only three pairs of pores (Lovén 250); *Strongylocentrotus» lividus* has only 3 pairs of pores in the lower ambulacral plates; *Echinostrephus* has 2—4 pairs of pores, oftenest 3 pairs etc.

By these researches the pedicellariæ and spicules proved to be of very great systematic importance; they give the most excellent characters we may want. To be sure, this fact is no new discovery. It has long been known that these organs and structures were more or less differently constructed in the different species and genera; much has been written about this fact, and a great many figures have been published. But nevertheless the fact has never been fully utilised.

The history of the pedicellariæ is highly interesting; scarcely many zoological objects will be able to vie with these organs with regard to the number of interpretations. From parasites to embryos, and even to vertebrates, and back again to parasites their history passes, until they are generally acknowledged to be what they really are: organs forming integral parts of the animal. v. Uexküll has given an excellent account of their history (406), and so there is no reason to give it here again. I shall only here note a few less important treatises, not mentioned by v. Uexküll, viz. by Duncan (130), Groom (175), and Stewart (381). A little note by Troschel (Verhandl. d. naturhist. Vereins d. preuss. Rheinl. u. Westphalen. 1870 p. 137) is also to be mentioned for the sake of completeness; it contains nothing new.

The histological structure of the pedicellariæ has of late years been very carefully studied, especially by Foettinger (155), Hamann (184), Sladen (366), Prouho (327), and v. Uexküll (406). The most interesting ones in this respect are the globiferous pedicellariæ, which have proved to be

poison-apparatus of a very peculiar and complicated structure with sensitive cilia, poison-glands etc. Only a single point seems hitherto not to have been fully understood, viz. how the poison gland opens through the large tooth at the end of each of the three valves forming the skeleton of the head of the pedicellaria. Perrier[1]) thinks that in some there is a large lacune mediane in the end-tooth, in others he finds two terminal teeth beside each other. The latter fact is also stated by Valentin[2]) with regard to *Strongylocentrotus lividus*. Sladen (366, p. 105) describes the end-tooth as channelled and presenting the appearance of two or more lateral lamellæ merged together to form the tip or tooth-like fang. Stewart alone seems to have seen the fact correctly; he says (381, p. 910) of the globiferous pedicellariæ in *Echinostrephus*: The jaw terminates in a long, deeply grooved fang; the groove, which is almost converted into a canal by the meeting of its margins, opening at a point near, but never at the tip on the external or distal surface». But this correct description seems to have been overlooked. Neither seems the most recent author on this subject, v. Uexküll, to have understood the structure correctly, although he is not much mistaken. He says (op. cit. p. 364): Die Verdickung (the upper end of the blade where the end-tooth issues) weisst jederseits eine längliche Öffnung auf, von der aus je ein Canal ins Innere tritt. Die beiden Canäle vereinigen sich in der Mittellinie zum unpaaren Giftcanal, der bis nahe an die Spitze des Endhakens läuft um hier dorsal zu münden. Der Endhaken zeigt am äussersten Ende noch eine aufgesetzte feinste Spitze. According to this description v. Uexküll seems to think that the poison-canal runs quite inside the tooth, which would thus be tubular.

An essential reason why the authors have not hitherto succeeded in reaching the correct understanding, is no doubt that *Sphærechinus granularis* has especially been used as the subject of examination, and in this species the structure of the tooth is only to be seen with some difficulty. If, on the other hand, an *Echinus* or a *Psammechinus* is used, the structure is easily seen, and when first it is understood, it is also easily seen that the pedicellariæ of *Sphærechinus* are in reality constructed in the same way. — When the fang is viewed from above, the poison-canal is seen to be an open groove on the upper surface of the fang (Pl. XVII, Fig. 15), the whole reminding of the poison-fangs in the opistoglypha. As mentioned by v. Uexküll, the canal runs out a little before the point; to speak of «eine aufgesetzte Spitze» is misleading. (In the Cidaridæ the structure of the globiferous pedicellariæ is quite different, as described below.)

As far as I know there is in literature next to no more exact accounts of the development of the pedicellariæ of the Echinoids[3]). Only Prouho (327) gives some excellent figures of the first stages of development, but only of the histology; the development of the calcareous skeleton is not mentioned. Agassiz, in the «Challenger»-Echinoidea (8) Pl. II, Fig. 16, gives some figures of developmental stages of pedicellariæ in *Goniocidaris canaliculata*; but only the outer contour is given, and mention is made neither of the histology nor of the calcareous skeleton. No further direct observations seem to be found. — Generally, the small pedicellariæ have been regarded as developmental

[1]) Recherches sur les Pédicellaires et les Ambulacres des Astéries et des Oursins. Ann. Sc. Nat. 5. Sér. XII—XIII. 1869—70.
[2]) Anatomie du genre Echinus. (Agassiz: Monographies d'Echinodermes.) 1842.
[3]) On the development of the pedicellariæ in Asteroidea Agassiz gives some informations. (Rev. of Echini IV.)

stages of the large ones of the same kind. Duvernoy[1]) even thinks all the different kinds of pedicellariæ to be developmental stages of a single, definitive form, pedic. tridens. Valentin (Op. cit. p. 49) writes of the triphyllous pedicellariæ: «Je n'ai pu m'assurer si ce sont des pédicellaires d'une espèce particulière, ou s'ils ne sont que le jeune âge des pédicellaires ophicephales», and Agassiz, in «Rev. of. Ech.» p. 665, says: «in *Echinometra* there is no doubt these trifoliate pedicellariæ are only the younger stages of the tridactyle forms». Scarcely any student of these forms will now-a-days suppose one form of pedicellariæ to be a developmental stage of the other. On the other hand it must be admitted that at a first glance the small pedicellariæ might appear to be developmental stages of the larger ones of the same kind. A little reflection, however, will immediately show the improbability of this supposition; what re-arrangements were to take place in the calcareous mass to make a small fully formed pedicellaria become a large one! — Pedicellariæ are not rarely found that seem either to be only half-formed, or half-decomposed. The possibility that they might be somewhat decomposed, because the preserving fluid had become acid, has to the dismissed at once, — if this were the case the lime would be corroded everywhere, and not only the outer edge be decomposed. Döderlein (116) has seen and figured such half-formed pedicellariæ of *Stereocidaris grandis* and «*Leiocidaris verticillata*», and regards them as a separate kind. «Es scheint noch eine vierte Form von Pedicellarien bei den Cidariden zu geben, von der ich aber bisher nur einige isolierte Klappen gesehen habe, die sich auf Präparaten ganz vereinzelt neben den anderen Formen fanden. Diese «korbförmigen» Klappen zeigen eine sehr weite, bauchige Kammer, die am oberen Theil in einer sehr grossen Öffnung mündet; diese Öffnung zeigt einfache dünne und etwas gekerbte Ränder; von Zähnelung u. dgl. ist keine Spur vorhanden. Solche Pedicellarien erreichen bei *C. grandis* die Grösse und die äussere Gestalt der dickköpfigen Form, sie sind dagegen sehr klein bei *L. verticillata*; bei anderen Arten kenne ich sie nicht, auch ihren Standort konnte ich nicht entdecken» (op. cit. p. 33). For a long time I had no clear understanding myself how to interpret this form, until I found some specimens of *Phormosoma placenta* possessing such structures in large numbers and in different sizes, and then there was no doubt that they are developmental stages of pedicellariæ. On Pl. XII, figs. 15, 24, 30, 38 the development of a triphyllous pedicellaria is given. The part first formed is the basal part of the three valves and the stalk (its upper end); they seem to appear contemporaneously. From the basal part then the blade grows up, and new calcareous particles being constantly added all round, it grows in breadth and height; the apophysis is early formed. The figures give, better than a long description, an idea of the way in which the growth takes place. Where a distinct margin is formed the growth is completed. The margin is first formed below when the definitive breadth has been reached, and is then continued towards the upper end. A large pedicellaria is begun with a broad base, a little one with a narrow base. No growth takes place when a coherent margin has been formed all round the valve. — On Pl. XII, figs. 4—5 is shown a developmental stage of a large tridentate pedicellaria. — I have found such stages of development in most of the species I have examined.

Already Duvernoy (op. cit.) and W. B. Herapath[2]) lay stress upon the fact that the pedi-

[1]) Mémoire sur l'analogie de composition et sur quelques points de l'organisation des Echinodermes. Mém. de l'Inst. de France. XX. 1849. p. 611.

[2]) On the Pedicellariæ of the Echinodermata. Quart. Journ. micr. Sc. (N. S.) V. 1865. p. 175—84. Pls. IV—V.

cellariæ of the Echinoids give good specific characters. Stewart, Koehler, Döderlein, Wyv. Thomson, a. o., but especially Perrier and Agassiz have later described pedicellariæ of a great many different Echinoids, and have shown that here an immense richness in forms is found, and that they give characters with regard as well to families, as to genera and species. Nevertheless the pedicellariæ have only a few times (in Wyv. Thomson's classical work on the »Porcupine»-Echinoids (395) and Döderleins as excellent work on the Cidarids (116)) been treated as being of importance in the systematic works; generally they have only been mentioned as a matter of small importance beside the description proper, and often no attention at all has been paid to them. Rarely all the different forms of pedicellariæ in a species are described, and still less in all species of the same genus; of one species an ophicephalous and a tridentate pedicellaria is figured, of another a valve of a globiferous one, of a third perhaps none at all, etc. In this way, of course, we shall never get a clear understanding of the systematic characters which may be found in these small organs. The pedicellariæ in effect give absolutely excellent systematic characters, sometimes only specific characters, sometimes also generic ones.

The use of the pedicellariæ in classification is attended with great advantages; they do not change their form with age, but are in the newly metamorphosed Echinoid of the same form as in the grown one, only somewhat smaller in the small specimens. It is therefore (oftenest) possible, by means of the pedicellariæ, easily to determine quite small Echinoids with absolute certainty — at all events as to genus. Another advantage is that it is not necessary to remove the spines in order to get a view of the tubercles, the specimens have not to be destroyed for the sake of determination.

It may, perhaps, seem unreasonable to lay so much stress, as is done here, on so minute features as the pedicellariæ — to use them for the characterizing of as well species as genera and families. But when it proves to be a real fact that these minute features give excellent, constant characters, it may be taken to be reasonable to use them without regard to their being small or large. Surely any student of Echinoids will also feel it as a great advantage not to be obliged to be contented with all these relativities, as the length and number of the spines, the size of the tubercles, the form of the test etc. To all these things, of course, regard must always be paid, and so has also been done here, as far as the material has permitted. But the pedicellariæ are, at least, as important. I can completely subscribe the expressions of Stewart (381 p. 912): It seems to me most desirable that minute, and even apparently trivial, features should be given in the descriptions of species, and that when this is more done, we may find affinities between forms, we should otherwise not suspect, and be enabled by the examination of even an ambulacral tube or pedicellaria etc. to determine a species without the denudation of portions of the corona, which is sometimes not desirable».

The supposition by Stewart that by an examination of the pedicellariæ etc. we might find a closer relation between forms not otherwise regarded as related, has been amply justified by these researches, even to so high a degree that the classification hitherto used proves to be quite a failure (with regard to the groups treated of here). A good proof of the correctness of the new classification given here, which has been found especially by the examination of the pedicellariæ, is found in the fact that forms with the same kind of pedicellariæ also agree in other important respects. To

be sure, the material has not been sufficient for a thorough examination of all characters with regard to some groups (especially the Cidarids), but I think that from the results found elsewhere we shall be justified in supposing that it will appear everywhere to be a fact that forms with the same kind of pedicellariæ in reality belong to the same natural group.

It is a serious drawback that the pedicellariæ cannot be used in the classification of the fossil Echinoids. Groom (175), to be sure, has described the pedicellariæ of *Pelanechinus corallinus* in a very well preserved state, and it will, no doubt, also be possible to find them in well-preserved specimens of other fossil Echinoids; of course, however, it will always be a rare thing — generally we have here to be content with the tests (and the spines). These structures also often give excellent characters, but they are far from being always reliable. The former great incertainty in the determination of the recent forms of regular Echinoids (and I think it is not much better with regard to the irregular ones) may be taken to imply that there cannot be any great certainty in the classification of the fossil forms either.

As is well known, no less than four different kinds of pedicellariæ are found in an *Echinus*, viz. globiferous pedicellariæ, tridentate, ophicephalous, and triphyllous ones. Of these forms the triphyllous and ophicephalous ones have only very little systematic importance; they are very much alike in almost all Echini. The tridentate ones give often excellent specific characters; the globiferous ones are generally very much alike in related species, but show very characteristic differences in the different genera. Especially the latter form shows many peculiarities. The structure of the blade is highly different; it may be open or shut, the margins having coalesced on the inside; there may be many or few teeth along the edge, placed symmetrically or unsymmetrically, or teeth may be quite wanting. On the other hand no forms are known with more than one end-tooth[1]). When Perrier (op. cit.) says that the globiferous pedicellariæ in the Echinometrids end in two hooks, one placed a little above the other, this statement is not quite correct. There is also here only one end-tooth, with the mentioned open canal on the upper side; the other one that is placed below the former, is a lateral tooth with no poison-canal, homologous with the lateral teeth of the pedicellariæ in *Echinus*. Here thus is only one unpaired lateral tooth. In *Sphærechinus*, *Strongylocentrotus* etc. no lateral teeth are found at all, only a little obliquity is seen towards the end of the blade, a little process on one side, perhaps a reminiscence of the unpaired lateral tooth in the Echinometrids. — Some *(Strongylocentrotus)* have a long, muscular neck between the stalk and the head; in most forms the head is placed directly on the end of the stalk. Even the structure of the stalk is very different, in some forms it is a perforated tube, in others some thin calcareous threads, irregularly connected by short cross-beams, or it may even be a single thin calcareous thread. Some forms have large mucous glands on the stalk. In the Cidarids the stalk is very peculiar, with an upper thin part and a lower thick one; at the transition between the two parts a limb of projecting calcareous ridges is often seen.

The mentioned four different kinds of pedicellariæ are found in the old families *Echinidæ* and *Echinometradæ*. In the Echinothurids globiferous pedicellariæ are only found in a single genus *(Hapalosoma)*; they are highly peculiar (Pl. XIII, Figs. 20, 24, 25), obviously very primitive. The calcareous skeleton consists of three simple rods lying between the three (mucous?) glands, each

[1]) Comp. however, the description of the globiferous pedicellariæ in *Stomopneustes*.

of which ends in a fine pore at the end. The rods reach only half-way, the whole thing is coalesced to the very point; there are no muscles between the basal parts of the valves. In another genus *(Araeosoma)* a singular kind of pedicellariæ are found, the tetradactyle, with four peculiar, very elegantly formed valves. Also in other Echinoids a four-valved pedicellaria may now and then be found, but only as an abnormity. Ophicephalous pedicellariæ[1]) are among the Echinothuridæ found in only a single genus *(Tromikosoma)*; on the other hand, triphyllous and tridentate pedicellariæ are found in all of them, and especially the tridentate ones show a great variety of forms, and are of great systematic importance. In the Cidarids are found tridentate pedicellariæ, and another kind occuring in a large and a small form, of substantially the same structure. They seem to be poison-apparatus as the globiferous pedicellariæ of the Echinidæ; but they are of a quite different structure, the gland being here placed inside the blade, quite surrounded by the calcareous skeleton, while in the Echinidæ it is situated on the outside of the blade. On the inside of the blade, somewhat below the point, there is a larger or smaller opening (»the mouth«) in the calcareous skeleton, filled with large cells, richly provided with cilia (sensitive hairs?). The efferent duct of the secretion of the gland passes up through the end-tooth, and opens on its surface. How these structures are arranged in forms with no end-tooth is unknown. The inner opening is of great systematic importance, while the glandular opening itself scarcely is of any importance in this respect. Perrier (op. cit.) gives these pedicellariæ a special name »Pedicellaires armées». After the discovery of the above described form of globiferous pedicellariæ in the Echinothurids[2]) there seems to be sufficient reason to take these pedicellariæ in the Cidarids to be homologous with the globiferous pedicellariæ of the Echinoids, as has also been done by Stewart (379) and Prouho (327), so that there is no cause to keep the name given to them by Perrier. There is still less reason to keep the name »Ped. inermes» for the tridentate pedicellariæ of the Cidarids; there can be no doubt but that they correspond to the tridentate pedicellariæ of the other Echinoids (Prouho (327), Koehler (217)). Hamann (184) regards the small pedicellariæ as »a subspecies of the tridactylous ones». Now it has to be admitted that sometimes it may be rather difficult to distinguish between these latter and small tridentate pedicellariæ; but generally they are very easily recognised, and there is no doubt that, with regard to structure, they resemble very much the large globiferous pedicellariæ. Where no pronounced difference is found between large and small pedicellariæ, it may in fact be impossible to decide, whether a certain specimen is to be regarded as a large or as a small form. There seems to be no reason to give a special name to the small pedicellariæ; in the present work they will the mentioned as »small globiferous pedicellariæ». — Ophicephalous and triphyllous pedicellariæ are not found in the Cidarids.

O. F. Müller[3]) has originally given names to the pedicellariæ, viz. Pedicellaria globifera, triphylla, and tridens. These names have not been generally accepted, the reason being especially that Valentin in his classical monograph on the anatomy of *Echinus* has used other appellations: Pedicellaire gemmiforme, tridactyle, and ophicephale; these names have become the common ones. Sladen (366) justly maintains that it is incorrect to use these latter names. The figures of Müller

[1]) What has hitherto been regarded as ophicephalous pedicellariæ in the Echinothuridæ, are in reality triphyllous ones.

[2]) Also the globiferous pedicellariæ in *Stomopneustes* seem to form a peculiar type. They have no end-tooth, and there seems to be no poison gland on the outside of the blade.

[3]) Zoologia danica. 1788. pag. 16. Tab. XVI.

are perfectly recognisable, and therefore his names ought to be restored to their rights. The name of P. triphylla of Müller, however, no doubt includes as well ophicephalous pedicellariæ as triphyllous ones. This name must then be kept for the small form the valves of which resemble clover-leaves, while Valentin's name P. ophicephale is kept for the form described by him under this name. — Hamann (184) uses the name «Globiferen» especially of the pedicellariæ where the mucous glands on the stalk have been so highly developed, that the head has become rudimentary or is even quite wanting. Thus they, as is also admitted by Hamann himself, are not a peculiar kind of organs, but only transformed pedicellariæ; it may, perhaps, be as well to have a special name for these pedicellariæ, but the name of «Globiferæ» cannot be restricted to them, as has also been observed by Duncan (130). It is, in reality, contrary to all common practice not to use the names of Müller. The reason for keeping Valentin's names given by Geddes and Beddard (163): «both on account of their general acceptance and because they were the first names applied to pedicellariæ after the determination of their real nature; Müller's nomenclature refers to pedicellariæ as a genus of parasitic animals», is not sufficient for a disregarding of the common rules of priority. Accordingly the names that ought to be used, are the following:

Globiferous pedicellariæ	*Pedicellaria globifera* Müller	= Pedic. gemmiforme Valentin, Perrier. P. armé Perrier (in the Cidarids). «Globiferen» Hamann.
Tridentate	*trideus*	= P. tridactyle Valentin etc. P. inerme Perrier (in the Cidarids).
Ophicephalous	*ophiocephala* Valentin	= P. triphylla Müller pro parte. P. buccale Valentin, Hamann.
Triphyllous	*triphylla* Müller	= P. trifolié Perrier.

To facilitate the understanding of the descriptions in the following, figures are annexed showing a single valve of each of the four kinds of pedicellariæ together with the names used for the separate parts.

To be able to study the pedicellariæ, especially the calcareous skeleton, which is of particular importance for the classification, they must necessarily be treated carefully. On being boiled in a not too strong solution of potash the separate pieces of the skeleton may easily be isolated, and no very great technical skill is necessary to be able to make preparations in Canada balsam of these pieces. (They cannot be kept in glycerine, as it resolves the lime). Accordingly I can in no way subscribe to the opinion of Pomel that the pedicellariæ only with difficulty can be used for the classification, because «leur ténuité en rend l'étude peu pratique» (324 p. 13).

Also the spicules yield good systematic characters, even if they are not, in this respect, equal to the pedicellariæ. They only rarely yield specific characters, and are oftenest very similar in the separate genera of the same family, but they may yield excellent family characters. They may be of a simple C-shape («bihamate») — the most common form — or a little branched in both ends (*Strongylocentrotus*), or pointed in both ends, and with one branch or a couple of small branches in the middle, «biacerate» (*Parasalenia*, *Anthocidaris*); in *Sphærechinus* and especially in *Toxopneustes* and

Tripneustes they are dump-bell-shaped, and in many genera they are irregular, perforated calcareous plates. Perrier (op. cit.) and especially Stewart[1]) have figured the spicules of many Echinoids; but they have not, any more than the pedicellariæ, hitherto been of any importance in the classification.

The sphæridia do not appear to show such differences in structure that they may yield systematic characters. On the other hand the structure of the spines is of no small systematic importance, as especially shown by Mackintosh (264—265), and they are never to be passed by in the descrip-

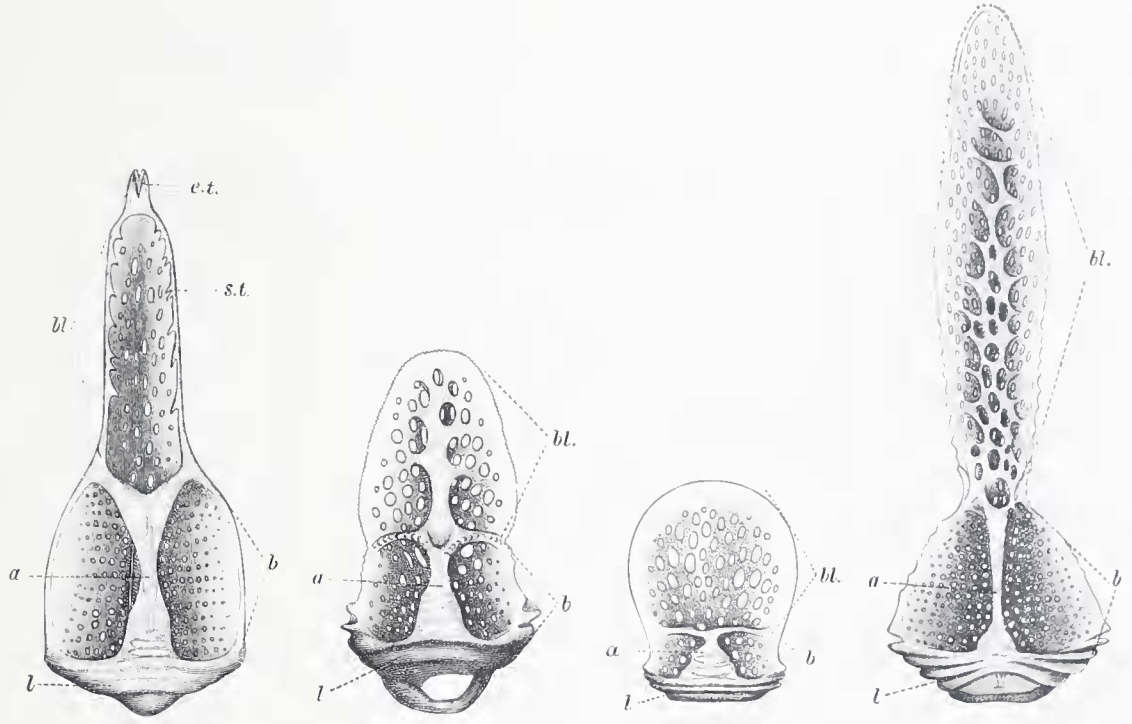

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Fig. 1. Valve of a globiferous pedicellaria of *Parechinus miliaris* (Müll.)
— 2. — - an ophicephalous pedicellaria of *Strongylocentrotus drobachiensis* (O. F. Müll.)
— 3. — - a triphyllous pedicellaria of *Parechinus miliaris.*
— 4. — - a tridentate pedicellaria of *Strongyloc. drobachiensis.*
In all the figures *a.* means the apophysis, *b.* the basal part, *bl.* the blade, *e.t.* the end-tooth, *s.t.* lateral teeth, *l.* the articular surface.

tions — as indeed nothing that may be of systematic importance. Above all, the most easily accessible and most reliable characters, viz. the pedicellariæ and spicules, ought never to be omitted in systematic descriptions of Echinoids.

Fam. Cidaridæ.

With regard to the classification of the Cidarids, all authors seem to agree in only one thing, viz. that all attempts made hitherto at giving a natural limitation to the genera have failed. Every

[1]) On the Spicula of the Regular Echinoidea. Transact. Linn. Soc. London. XXV. 1865. p. 365—71. Pl. 47—50.

writer upon the classification of the Echinoidea since Desor has complained of the unsatisfactory attempts of some of the most distinguished authorities to subdivide the genus Cidaris ... The divisions were made upon very unimportant external characters, and subsequent research has proved that these structures, the variations of which led them to be considered of good diagnostic value, are of no physiological importance» (Duncan (132 p. 29)). In the excellent principal work on the Cidarids, Döderlein's «Die japanischen Seeigel» (116) he says (p. 35): «Eine wirklich befriedigende Gruppierung der lebenden und fossilen Cidariden in Gattungen und Untergattungen ist bisher eine ungelöste Aufgabe gewesen und wird es wohl noch lange bleiben». And then follows, to boot, a remark, anything but encouraging to a systematist, that «es ist durchaus nicht zu erwarten, dass die Abgrenzung der Gruppen bei zunehmender Kenntniss eine schärfere werde». — Nevertheless I shall here make an attempt to solve the problem: the classification of the Cidarids.

Agassiz in his «Revision of Echini» keeps the genera: *Cidaris*, *Dorocidaris*, *Phyllacanthus*, *Stephanocidaris*, *Porocidaris*, and *Goniocidaris*; *Dorocidaris* and *Phyllacanthus*, however, are more nearly regarded as subgenera under *Cidaris*, what is also especially remarked later, in the «Challenger»-Echinoids (8 p. 33). They are here further defined in the following way: «*Dorocidaris* would include all forms with narrow ambulacral areas and long slender, serrated spines, while *Phyllacanthus* would include species with broad ambulacral areas, having the poriferous zones joined by a furrow more or less distinct; while *Cidaris* proper would be restricted to species, in which the pores of the poriferous zone are not so connected». Wyville Thomson (395 p. 772) among the recent Echinoids only acknowledges the genera *Cidaris*, *Porocidaris*, and possibly *Goniocidaris*. Pomel (324) divides the Cidarids into three subfamilies, viz. *les Cidariens* with the genus *Eucidaris* (with «trois espèces vivantes», none of which are mentioned) as the only recent representative; *les Goniocidariens* with the recent genera *Goniocidaris* and *Dorocidaris*; and *les Rhabdocidariens* with the genera *Phyllacanthus* (with the subgenus *Stephanocidaris*), *Leiocidaris* and *Porocidaris*. The genus *Schleinitzia* Studer is supposed to be a *Rhabdocidaris*, consequently also to belong to this subfamily. Duncan (132) only admits the genus *Cidaris* with the subgenus *Goniocidaris*; the other earlier genera are only classed as «divisions». De Loriol (245) comprises a great number of species under the name of *Rhabdocidaris* Desor; but he owns (p. 7) that «au fond, toutes les tentatives, qui ont été faites pour demembrer le grand genre Cidaris, n'ont pas été heureuses; on trouvera toujours tant de passages entre les espèces, en apparence les plus distinctes, qu'il est douteux pour moi, s'il est vraiment nécessaire de diviser ce genre admirable, qui apparaît dès la fin de l'ère paléozoique et traverse dès lors tous les étages, sans manquer dans aucune, pour se retrouver enfin dans les mers actuelles sans avoir modifié aucun de ses caractères». The most important contribution to the classification of the Cidarids has been given by Döderlein in his above quoted, large and excellent work «Die japanischen Seeigel» where he attempts to group as well the recent forms as the fossil ones according to their real relation. With regard to the recent forms the following genera are retained: *Dorocidaris*, *Stereocidaris* (known until then only as fossil from the cretaceous period), *Eucidaris*, *Leiocidaris*, *Porocidaris*, and *Goniocidaris*. But neither is the limitation by Döderlein of these genera satisfactory; above all it holds good with regard to his genera as well as with regard to those of the other authors that nobody is able to recognise them with certainty by the diagnoses given, — when upon the whole diagnoses are given. After all it is a

matter of judgment, to which genus one species or another is to be referred, and most of the species more frequently mentioned have also by and by been referred to almost all the different genera. So far it is very consistently done by Duncan and Bell (73) quite to strike out all these undistinguishable genera, and only retain the old genus *Cidaris*; but then on the other hand this way of proceeding means quite to abandon the pursuit.

The reason why the result of the earlier attempts at classification has been so meagre, has to be sought in the characters used. The most important ones have been, whether the two pores of each ambulacral plate are connected by a groove or not, and whether the tubercles are crenulated or not. Further the spines, the number of plates, the breadth of the ambulacral area, and upon the whole the structure of the test have been considered of great importance. All these characters, however, are insufficient or even unreliable. As has been pointed out by both Döderlein and Duncan, it is often impossible to decide, whether the pores are or are not connected by a groove. The crenulation is a very variable character; crenulated tubercles may be found in some individuals belonging to species normally without crenulation. The structure of the test, the tubercles, the number of plates etc. are very much dependent on the age of the animal. All these characters, says Duncan, are «of no physiological importance whatever; any classification in which these characters are used is artificial». On the other hand he thinks that «the number of interradial plates (is) of physiological importance; and there is a great temptation to consider typical Cidarids as having but a few, say not more than seven, in a vertical row» (132 p. 30). This character seems to be at least as gratuitous, as the others criticised by Duncan are relative ones; neither seems the result of his systematic researches in any way to show that he has found here a systematic character of any great importance.

Among the characters hitherto used in the classification, the spines seem to be one of the most reliable. They show a great richness of forms, but are at the same time of a rather constant form in the separate species. Also their microscopic structure differs to a high degree, and here, perhaps, we might find good generic characters. There are in the literature not a few examinations of the structure of the spines in the Cidarids. Stewart[1]), Bell (57), and Agassiz (Revision of Echini and Chall. Ech.) have figured transverse sections of the spines of different species; but especially H. W. Mackintosh has rendered great services to the question by his excellent researches on the structure of the Echinoid-spines (264—65). The spines of the Cidarids differ from those of the other Echinoids by having a compact outer layer («*ostracum*» Bell); (such a layer is also found, however, in *Salenia* and *Arbacia* (on the point of the spines)); — «acanthostracous» this kind of spines is called by Mackintosh. Unfortunately it cannot with certainty be inferred from the existing examinations whether the structure of the spines yields good generic characters. Mackintosh is decidedly of opinion that the spines really yield characters of that importance; he finds instances «in which the acanthological characters would seem to call for a change in the position of a genus» (265 I p. 478), and he lays stress on the importance of always mentioning the structure of the spines in the description of Echinoids. Otherwise he has examined too few Cidarids to have got a sure impression of the

[1]) On the minute structure of certain hard parts of the genus Cidaris. Quarterl. Journ. Micr. Science. N. S. XI. 1871. p. 51—55. pl. IV.

systematic importance of the spines in this family. Bell (57) who has examined the spines in *Goniocidaris florigera*, *Phyllacanthus imperialis*, and *Stephanocidaris bispinosa*, finds that «within the limits of the true Cidaridæ stages in the extent of the fenestration, and the regularity of the spoke-like intermediate layers are to be observed; when combined with the inquiry into the relations of other structural characters .... they will perhaps be found to be of use in determining the minor questions of the limitations of the genera, of which that family is composed».

No doubt Bell is right when he thinks that the structure of the spines will be of systematic importance; it is, however, not the inner structure, which is highly homogeneous, but the outer layer that is of importance here. From the sections of the spines of 5 different Cidarids figured on Pl. XI, Figs. 1, 3, 14, 24, 31, 33, it will be seen that the outer layer is constructed in a highly different way. Sometimes it is quite smooth, with no indication of any roughness whatever on the surface, sometimes it is richly set with small, hairlike outgrowths especially between the ribs. These «hairs» may be more or less branched, and they may unite so as to form a dense reticulation. Special attention must, accordingly, be paid to this outer layer; no doubt, valuable characters will be found here, but for the present nothing can be said with regard to the fact whether only specific characters, or, what is more probable, also generic characters may be found. A clearer view of this question is not to be got until a larger number of species has been examined. The accounts hitherto given, unfortunately, have not been sufficiently exact with regard to the outer layer, so that they are not to be trusted in this respect. As it is the outer layer, which is mainly to be considered, it is of no use to examine old spines, they must be fresh, so that the outer layer is still undamaged (such as are not overgrown by foreign organisms).

The spicules of the tube feet seem only to be of slight systematical importance. Commonly they are formed like bows reaching over about half of the circumference of the foot or somewhat less. They are more or less spinulous; in some species of *Stereocidaris* they are formed as larger, fenestrated plates. Generic characters would seem not to be found in the forms of the spicules.

Then only the pedicellariæ are left where we might expect to find good specific characters; but to judge by the statements in the existing literature, it would also seem beforehand to be rather hopeless. Perrier, in his well-known large work on the pedicellariæ, has given (not very exact) figures and descriptions of several forms; but their systematic importance does not clearly appear from these figures and descriptions. Stewart (op. cit.) has given an excellent figure of a pedicellaria of «*Cidaris annulata*». According to Agassiz (Revision of Echini) *C. annulata* A. Ag. is = *C. tribuloides* Lamk., and *C. annulata* Gray = *Phyllacanthus annulifera* A. Ag. The figured pedicellaria, however, cannot belong to any of those species, although Agassiz (Revision p. 99) mentions the quoted work of Stewart under *C. tribuloides*; it seems to be a *Goniocidaris*, but which species cannot be determined. In (379) Stewart further gives a couple of excellent figures of globiferous pedicellariæ in *Porocidaris papillata*. Also Wyville Thomson (395) gives excellent figures of the pedicellariæ in *Porocidaris papillata* and *Porocidaris purpurata*. In «Revision of Echini» and in the «Challenger»-Echinoids (8) Agassiz figures pedicellariæ of several Cidarids, but generally the figures are not good. Döderlein (116), however, is the first author, who has tried to use the pedicellariæ in a correct way in the classification of the Cidarids. He has studied the pedicellariæ in a larger number of species, and

thinks that they often give excellent specific characters, but he was disappointed in ihrer erhofften Verwendbarkeit zur Unterscheidung natürlicher Gruppen innerhalb der Familie (p. 1). Nur mit grosser Vorsicht dürfen Pedicellarien als systematische Merkmale bei den Cidariden benützt werden. The small pedicellariæ are highly similar in almost all species, but they may vary very much in the separate individuals. (Only the form with a long terminal hook, occurring in *Goniocidaris mikado* and *clypeata*, is especially mentioned). The tridentate ones (löffelartige Form) are better, but they are also highly varying in the separate individuals. Most applicable for the classification is the thick-headed form, (the large, globiferous pedicellariæ); it is highly constant in form and size, and shows many peculiarities, «die sehr wohl einzelne Arten, manchmal auch Gruppen charakterisiren können». He also tries to group the species according to these peculiarities, without, however, attributing to them any great systematic importance, and therefore he does not mention the pedicellariæ in his diagnoses of genera. The fact is that also this form of pedicellariæ shows some variability, is sometimes even quite wanting in some individuals, so that it is no quite reliable character. An extraordinary fact is «dass sehr ähnliche Formen dieser Pedicellarien bei Arten vorkommen können, die nach den übrigen Charakteren sehr wenig Verwandtschaft mit einander bekunden» (*C. metularia* and *verticillata*). His final result is: «In vielen Fällen hat nun ohne Frage die Vergleichung der Pedicellarien nicht geringen Werth für die Systematik; sie geben jedenfalls sehr brauchbare Charaktere zur Unterscheidung der Arten. — Zur Charakterisierung von grösseren Gruppen innerhalb der Familie finde ich aber Pedicellarien sehr wenig verwendbar» (p. 34).

And so the last hope of finding good generic characters in the Cidarids seems to have vanished. Fortunately, however, my researches have given another result than that of Döderlein, viz. that the pedicellariæ yield excellent generic characters, while they may only more rarely be used for distinguishing between the species. This seems to be irreconcilable with the above quoted statement of Döderlein that species not more nearly related, may have quite similar pedicellariæ. As instances are only named *Cidaris metularia* and *verticillata*. Now it is quite correct that they have the same kind of pedicellariæ; but then the question is whether the other characters, in which they differ, are sufficient to show that they cannot belong to the same genus. The most essential difference seems to be found in the spines, which are in *C. verticillata* provided with large thorns placed in circles far from each other, while in *C. metularia* the spines have the whole surface evenly set with homogeneous, small tubercles arranged in longitudinal series. Also with regard to the provision of the interambulacral plates with miliary tubercles a difference is found — they are almost naked in *C. verticillata*, closely covered in *C. metularia*. As it has otherwise proved to be a fact that the characters taken from the structure of the test have been anything but good as generic characters, and as there seems to be nothing unnatural in the fact that spines as those in *C. metularia* and *verticillata* are found in species of the same genus, I cannot but regard the fact of the two species having the same kind of (very characteristic) pedicellariæ as proving them to be nearly related, so that they will have to be regarded as not too closely allied species of the same genus. Besides there is another species of the same genus presenting considerably more resemblance to *C. verticillata* than the *C. metularia* mentioned by Döderlein. This is *C. baculosa* which is by Döderlein referred

to the same genus (*Leiocidaris*) as *C. verticillata*. In this species the thorns are often placed in circles in a somewhat similar way as in *C. verticillata*.

Especially the large globiferous pedicellariæ are of importance in the classification, the blade and partly also the stalk offering a great variety of forms. Also the length of the stalk is very different; this fact, however, has to be used with great caution, at it is very varying. Döderlein seems to put no small weight upon it. Also the small globiferous pedicellariæ are of rather great importance; more important, however, are the tridentate ones, which in a single genus, *Porocidaris*, are two-valved. In this genus (and perhaps in the genus *Histocidaris*) globiferous pedicellariæ seem to be quite wanting; on the other hand tridentate pedicellariæ are wanting in several other species — but perhaps not constantly. That the globiferous or tridentate pedicellariæ may sometimes be wanting, is mentioned by Döderlein as an objection to their being used in the classification. I cannot see, however, that this objection is sound; a corresponding fact would be, if we were to give up using the teeth of the mammals as systematic characters, because now one, now another kind, or even sometimes all of them are wanting.

When we now look over the Cidarids, and place together the species with similarly constructed pedicellariæ, we shall get a grouping rather differing from all hitherto given classifications.

Dorocidaris papillata: the globiferous pedicellariæ have a powerful hook at the point, above the large, somewhat lenghtened, not terminal opening; small pedicellariæ of the same form; the tridentate ones simple (Pl. IX, Figs. 7, 25). Quite similar pedicellariæ are found in *Dorocidaris Blakei* A. Ag. (Pl. IX, Fig. 16), which is accordingly a genuine *Dorocidaris*. On the other hand the following species that have been referred to *Dorocidaris*: *D. Bartletti* Ag., *bracteata* Ag., and *Reini* Döderl. differ widely from this genus, and are moreover so different from each other that they must be referred to three different genera.

D. Bartletti: the globiferous pedicellariæ have a long powerful hook at the point. The opening is exceedingly small, as a fine pore, surrounded by small teeth; it is placed rather far from the point. (Pl. X, Figs. 23, 30). The stalk is most frequently provided with a limb of freely projecting calcareous ridges. The small pedicellariæ are of the same structure, only the opening is larger; tridentate pedicellariæ simple. There can be no doubt but that this species must form a separate genus; I propose the name of **Tretocidaris**[1]). To this genus must further be referred the two following new species, which I found in British Museum, both under the name of *Dorocidaris papillata*.

Tretocidaris annulata n. sp. The globiferous pedicellariæ differ somewhat from those of *T. Bartletti* the inside of the blade being provided with some dentate transverse ridges and crests forming a coarse, irregular reticulation; at the upper end of the apophysis the margin of the blade is somewhat widened, highly fenestrated in a reticulate way, and bent a little outward (Pl. X, Figs. 22, 31). The stalk (Pl. IX, Fig. 4) and the other pedicellariæ as in *T. Bartletti*. The spines are finely annulated with brown rings, the upper spines have powerful thorns especially on the side turned up; they are tapering, about one time and a half as long as the diameter of the test; the actinal spines were wanting in the specimen. There is a rather deep, naked furrow along the median line of the interambulacral areas, and it continues between the plates outward to where the scrobicular areas join each other.

[1]) τρητός = bored.

There are 7 plates in the interambulacral areas. In the ambulacral area there is a little tubercle alternately between each two primary tubercles  , as in *Porocidaris purpurata*. The colour of the test is redbrown, and therefore the white, naked furrow of the interambulacral areas is especially conspicuous. — Locality: The West Indies (no nearer information). Should this species perhaps be Gray's *Cidaris annulata*?

Tretocidaris spinosa n. sp. The globiferous pedicellariæ have no such reticulation as those of *T. annulata*, and differ from those of *T. Bartletti* by the sides forming an almost straight line from the basal surface to the opening. (Pl. X, Figs. 10, 11). The small globiferous pedicellariæ as in the two other species (Pl. X, Fig. 16). On the stalk no distinct, freely projecting calcareous ridges are seen, only a marked swelling. (It is, however, possible that the limb of the stalk is found on other specimens; in the two other species it was not found either in all the large globiferous pedicellariæ); tridentate pedicellariæ were not found. The spines closely grooved, rather finely thorned, widened at the point, of the same length as the diameter of the test. The actinal spines smooth, not serrated, their points not widened. The small spines are strongly redbrown. There is a naked median line in the interambulacral area, but it is only little conspicuous. 9 plates in the interambulacral area; thus the large spines are somewhat more numerous than commonly, which gives to the animal a very characteristic appearance. The tubercles in the ambulacral areas as in *T. annulata*. Locality: St. Helena (no nearer information).

Dorocidaris bracteata Ag. The globiferous pedicellariæ much lengthened and narrow, with a powerful hook at the end, and a rather small, triangular opening a little below the point (Pl. X, Fig. 18); the small pedicellariæ of the same structure, tridentate ones simple. This form of pedicellariæ is further found in *Phyllacanthus» annulifera* (Lamk.), Pl. X, Fig. 17, and *Stephanocidaris bispinosa* (Lamk.), and these species will have to be united into one genus, which must keep the name of *Stephanocidaris*.

Dorocidaris» Reini Döderl. The globiferous pedicellariæ are of a very peculiar structure; the mouth is placed in the end of the blade, surrounded by well marked teeth on the margin which is bent a little outward. «Schnauzenähnlich vorragend» Döderlein says of the blade in this peculiar form of pedicellariæ, and it really resembles a snout to some degree. On the stalk a limb of short thorns is found. The small pedicellariæ are of a quite different structure, a well developed end-tooth being found here, and the large mouth situated below the point. This form of pedicellariæ is found in a series of species, viz. *Cidaris affinis* (Pl. IX, Figs. 9, 22, 24) (which is in no way synonymous with *Dorocidaris papillata*, as has been commonly supposed), *tribuloides*, *galapagensis* — and, I suppose, also in *Dorocidaris panamensis* Ag.; at all events this species, to judge by the figure, would seem to be most nearly related to *Cidaris affinis* and *Reini*; it is scarcely a *Dorocidaris*. The following species have pedicellariæ of the same structure, but are distinguished by having a limb of long, freely projecting calcareous ridges on the stalk of the globiferous pedicellariæ: *Cidaris metularia*, *Thouarsii* (according to Döderlein (116 p. 19) *Cidaris Thouarsii* has only a short limb on the stalk: the specimens examined by me have long limbs), *verticillata* and *baculosa*. Further has (according to the statement of Döderlein) *Phyllacanthus imperialis* the same kind of pedicellariæ (whether a limb is found on the stalk

or not, is not mentioned; I have not been able to find any large globiferous pedicellariæ in the few specimens I have examined), and the same, I suppose, holds also good with regard to *Phyllacanthus dubia* and *parvispina* Woods. Finally a similar form of globiferous pedicellariæ is found in *Goniocidaris florigera* Ag. (Challenger -Echinoids, Pl. I. Fig. 12) (Pl. X, Figs. 27, 29); in the latter there is no trace of a limb on the stalk.

Do now all these species belong to one genus? — Surely not. We shall first have to separate *Goniocidaris florigera*. It has no trace of a limb on the stalk, the spines differ considerably from those of all the other mentioned species, and I suppose that a closer examination will show several other peculiarities. Döderlein (116) thinks it to be most nearly related to the species *Goniocidaris clypeata* and *G. mikado* described by him, which species are distinguished by the spines being provided with a peculiar flat widening at the base. Traces of such a widening are also found in *G. florigera*; but the pedicellariæ of this species are so different from those of the two mentioned species that their being united into one genus is out of the question. It differs also from the gennine *Goniocidaris*-species (*G. tubaria* etc.) by its pedicellariæ; it must form a separate genus, for which I propose the name of **Petalocidaris**. There can scarcely be any doubt, however, that it is closely related to *Goniocidaris*.

Next *Phyllacanthus imperialis* must form a separate genus. It has peculiar large tridentate pedicellariæ, the blades of which are quite filled by a close net of meshes forming irregular longitudinal ridges closely set with small teeth (Pl. X Fig. 8); (the valve figured here, is from a smaller pedicellaria where only two longitudinal ridges are seen). The small pedicellariæ have no end-tooth (Pl. IX. Fig. 6). The spines are peculiar, thick, with fine longitudinal striæ. Together with this species *Ph. dubia* has no doubt to be placed — if upon the whole it can be kept as a separate species, of which I can have no decided opinion, as I have had no occasion to examine it. Also *Phyllac. parvispina* Woods must, to judge by the figure given by Woods (443), belong here; its spines resemble very much those of *Ph. imperialis* though Woods states them to be «entirely different from any described species». Also Ramsay (331 p. 45) says of this species that on the Australian south-coast it is the «representative of *P. dubia* of the North Coast». — This genus, no doubt, must keep Brandt's old name of *Phyllacanthus*. Brandt[1]) gives *Cidarites dubia* as the type of the section «*Phyllacanthus*», and observes that to this will have to be added *C. imperialis*, *hystrix*, *geranioides*, and *pistillaris*. The three latter can in no way be classed together with the two former; these two must keep the name of *Phyllacanthus*. Desor in his Synopsis des Echinides fossiles (1855) establishes the genus *Leiocidaris* (p. 48), and as the type of the genus he gives *Cidaris imperialis*. — Thus there will be no use for the name of *Leiocidaris*, it will only be a synonym of *Phyllacanthus*. — It will also be necessary to say some words of the much used name of *Rhabdocidaris* by the present occasion. The genus has been established by Desor (op. cit. p. 39) for fossil species; in a note is added: «Parmi les espèces vivantes on pourrait reporter à ce genre les *Cidaris tribuloides* et *C. imperialis*, si leurs tubercules n'étaient pas complètement lisses». De Loriol (245) has later enlarged this genus to comprise: 1) The fossil species of the genus *Rhabdocidaris* sensu stricto, 2) the *Rhabdocidaris*-species with smooth tubercles, 3) the species of *Leiocidaris* Desor and Dames (emend.), 4) the recent species of the genus *Phyllacanthus* Brandt, 5) the genus *Stephanocidaris* Ag., and 6) the genus *Schleinitzia* Studer. «Ainsi constitué, le genre *Rhabdocidaris*

[1]) Prodromus descriptionis animalium ab. H. Mertensio in orbis terrarum circumnavigatione observatorum. 1825 p. 68.

groupera naturellement un assez grand nombre d'espèces vivantes et fossiles et me paraît utile à conserver». The advantage of such a genus, however, seems to me to be rather illusory; with the limitation given by de Loriol *Rhabdocidaris* becomes still more heterogeneous than *Phyllacanthus*, as it is limited by Agassiz in Revision. As the genus has originally only been used of fossil species, it is quite impossible to decide whether some of the recent forms really belong to it; by the tests and the spines alone the genera cannot at present be recognised with certainty, and no pedicellariæ of fossil species are known. Accordingly the name of *Rhabdocidaris* is not to be used for any recent Cidarid.

On the other hand the other species with terminal opening on the globiferous pedicellariæ and limb on the stalk seem to form a natural group; the shortness or length of the limb can scarcely be used as a character for the subdivision of the group. Possibly *C. affinis* and *Reini* (and perhaps *panamensis*) will prove to form a special group — their spines seem to differ somewhat from the other mentioned species; but this can only be decided by more thorough examinations. For the present all these species: *Cidaris affinis*, *Reini*, *(panamensis?)*, *tribuloides*, *galapagensis*, *metularia*, *Thouarsii*, *verticillata*, and *baculosa*[1]) must form one genus, which must keep the old name of *Cidaris*, Linné's *Echinus Cidaris*, as has been proved by Lovén (252), being *Cidaris baculosa* Lamk. The name of *Eucidaris* Pomel, which has of late often been used for species of this group, cannot correctly be used. Pomel (324) enumerates as types of this genus some fossil forms (*morieri* etc.) from the trias, and «trois espèces vivantes», but he does not mention which species he means, and the fact is here, as in *Rhabdocidaris*, that it is quite impossible to decide whether any of the recent species belong to the same genus as the mentioned fossil ones.

Besides the species mentioned here, Döderlein still enumerates *Leiocidaris? annulifera* Lam. as belonging to those species, the globiferous pedicellariæ of which have terminal opening and limb on the stalk; here *C. annulifera* is referred to the genus *Stephanocidaris* which has a quite different form of pedicellariæ (see above) — a contradiction which can only have its origin from a difference in the interpretation of the species *C. annulifera* Lamk. This species together with *C. baculosa* Lam. have caused and still cause many difficulties to the systematists. Lamarck[2]) in his diagnosis of *C. annulifera* says: «spinis majoribus longis, tereti-subulatis, asperulatis, albo purpureoque annulatis», and in his diagnosis of *C. baculosa*: «spinis majoribus subteretibus, tuberculato-asperis, apice truncatis, collo guttatis»; according to this Agassiz (Revision of Echini p. 389) states as the only certain character of the highly varying *C. baculosa* «the spotted base of the shaft of the spine below the milled ring, which is of a light reddish or reddish-yellow ground-color, with deep violet spots marked extremely distinctly upon the fine longitudinal striation». Loriol (243) later describes and figures a Cidarid by the name of *C. annulifera* Lamk.; he has had a radiole of the type-specimen of this species for comparison, and has found it completely corresponding to those of the specimen described by him. These spines have «leur base couverte sur une longueur plus ou moins grande de petites taches pourpres, formant des lignes et entremêlées de petits points» — the character especially particular of *C. baculosa!* Thus, somehow or other, an error must have slipped in, and I think it most likely that

[1]) If *C. pistillaris* Lamk. be a good species, it must also be referred here.
[2]) Histoire naturelle des animaux sans vertèbres. II. Ed. 1840. T. III. p. 380.

the spine, which Loriol has got from Paris, has really been of *C. baculosa* — such a changing of loose spines in a museum is not absolutely inconceivable. The *C. Lütkeni* described by Loriol in the same work, seems rather to be the real *C. annulifera*, which must then be very nearly related to *C. bispinosa*, perhaps identical with it. Bedford (35 p. 274) also regards *C. Lütkeni* as synonymous with *C. annulifera* Lamk., but at the same time he seems to think it to be identical with Loriol's *C. annulifera*, which cannot be correct. Döderlein, who has examined a specimen of Loriol's *C. annulifera*, finds this species to be highly consistent with *C. baculosa*. Einen Unterschied zwischen den beiden Arten kann ich nur in der Färbung der Primärstacheln finden; denn selbst die Form der Primärstacheln kann bei bestimmten Individuen beider Arten identisch sein. — Nur die Färbung des Schaftes ist verschieden, indem *L. annulifera* Querbinden zeigt, die *L. baculosa* fehlen; die eigenthümliche und auffallende Tüpfelung des Stachelhalses dagegen, die sonst nirgends zu beobachten ist, findet sich bei beiden Arten in gleicher Weise. Nachdem aber eine Autorität wie Al. Agassiz auf Grund eines reichlichen Materials die Frage nach der möglichen Identität der beiden Arten überhaupt nicht aufwirft, kann ich es nicht wagen bei meinem ganz unzulänglichen Materiale eine solche zu behaupten. Ich kann hier nur constatieren, dass die oben beschriebene jugendliche *L. annulifera* nach ihren sämmtlichen Charakteren, abgesehen nur von der Färbung der Stacheln, unbedingt als ein junges Exemplar von *L. baculosa* gelten könnte» (116 p. 24). Prominence is also given to the fact that the pedicellariæ are quite identical. In another work (245) Loriol gives a thorough description and figures of *C. baculosa*, but its resemblance with the *C. annulifera* before described by him, is not at all mentioned. Thus the fact seems to be: either Loriol's *C. annulifera* is really this species — and then *C. baculosa* Lamk. and *C. annulifera* are synonyms — or it has, on account of some error or other, been wrongly determined — and then *C. annulifera* is most nearly related to *C. bispinosa* Lamk. (perhaps synonymous with it). The latter is the more probable. An examination of the type-specimens, especially their pedicellariæ, will easily decide this question. To be sure, Perrier has figured pedicellariæ of these two species, but unfortunately only so little exactly and minutely that he has not at all contributed to the clearing up of the question, especially as of one species he has only figured a globiferous pedicellaria, of the other only a tridentate one.

According to Döderlein (116 p. 25) *Schleinitzia crenularis* Studer is very nearly related to *C. baculosa*; Studer's figures (386) agree also partly with it, the separately figured spines having all the characteristic spots on the neck. On the figure of the whole animal these spots, however, are not found, and as, according to informations I have received from both Geh.rath, Prof. E. v. Martens and Prof. Döderlein, spines of at least two different species are found in the glass together with the type-specimen (v. Martens has sent me some of the spines), the safest plan will be to say nothing definite of this species, till the pedicellariæ of the type-specimen have been examined. Studer only figures the small form of the globiferous pedicellariæ.

Among the species referred to *Phyllacanthus* by Agassiz, still one has not been mentioned, viz. *Ph. gigantea* Ag. It differs from all other known Cidarids by its peculiar spines, as well primary as secondary ones; also its pedicellariæ are peculiar. The large globiferous ones (Pl. X, Figs. 15, 19) have a large cordate opening the lower limit of which is formed like a highly protruding lower lip; the opening reaches to the very point, and no end-tooth is found. No limb on the stalk. The

small pedicellariæ are of a somewhat different form (Pl. X, Fig. 26), and have a more or less powerful end-tooth. Tridentate pedicellariæ about as in *Dorocidaris papillata*, only with the edge somewhat more dentate. Spicules of the common form. It is obvious that this species cannot remain in the genus *Phyllacanthus* as here limited, or be referred to any of the mentioned genera; it must form a separate genus and retain the name of *Chondrocidaris*, originally given to it by Agassiz[1]).

The splendid *Cidaris curvatispinis* described by Bell (74), is in its whole appearance so unlike all other Cidarids that it is beforehand to be supposed that it represents a separate genus. The examination of its pedicellariæ also confirms this supposition. The globiferous pedicellariæ (Pl. VIII, Fig. 37) have no end-tooth; the opening is large, reaching to the point, but its lower limit is remarkably irregular — the figured one is one of the most regular; sometimes there seems to be no definite limit at all, the calcareous covering running out into irregular dents, as if it was broken off (which is, however, quite out of the question, as the pedicellaria was otherwise quite undamaged). The small pedicellariæ are of the same structure, the only difference being that the lower limit of the opening is here often a rather regular transverse line. (The possibility that the described and figured pedicellaria is really, in spite of its size, only the small form of the globiferous pedicellariæ, is not excluded; but on the only known specimen, which by the kindness of Prof. Bell I had the opportunity to examine in British Museum, there seemed to be found no other kind of globiferous pedicellariæ). The tridentate pedicellariæ (Pl. X, Fig. 9) are very peculiar, with some large, dentate crests of thin calcareous lamellæ longitudinally in the blade. No limb on the stalk. The spicules of the common form. For this species I propose the generic name of **Acanthocidaris.**

The genus *Porocidaris* is established by Desor (op. cit. p. 46) for some fossil Cidarids, especially distinguished by a circle of pores in the scrobicular area; to this genus Wyville Thomson (394—95) referred a Cidarid from «Porcupine under the name of *Porocidaris purpurata*. Whether it really belongs to this genus cannot be decided, till the pedicellariæ of the fossil species referred to it by Desor, become known. But to judge by what is hitherto known the species may well seem to be a *Porocidaris*, and for the present there seems to be no reason to reject this commonly used name, and *P. purpurata* W. Th. may then be put down as the type of the genus. Peculiarities of this genus are then the depressions in the scrobicular area (not pores as in the fossil species), the highly developed neck of the spines, the highly serrate edge of the actinal radioles[2]). But the most particular feature are the pedicellariæ. Only one form is found which must be referred to the tridentate ones; they are two-valved, highly compressed, and exceedingly large and conspicuous. The spicules of the common form.

To *Porocidaris* have later been referred the following species: *P. elegans* Ag., *Sharreri* Ag., *Milleri* Ag., *Cobosi* Ag., *gracilis* Sladen, *gracilis* Döderl., *misakiensis* Yoshiwara, and *incerta* Koehler. Of these species *P. gracilis* Sladen is, no doubt, only a young *P. purpurata*, and this name is then to be omitted as a synonym. *P. elegans* (one of the type-specimens (Challenger St. 164a) examined in British Museum): the tridentate pedicellariæ are widely different from those of *P. purpurata*. There

[1]) List of Echinoderms sent to different Institutions in exchange for other specimens, with annotations. Bull. Mus. Comp. Zool. I. 1863.

[2]) Especially the latter fact is often mentioned as characteristic of the genus; this, however, is not at all reliable, as sufficiently shown by these researches.

are two forms, a larger and a smaller, both three-valved. In the larger form the blade is filled by an exceedingly rich net of meshes, in which the holes are rather distinctly arranged serially, and radiate in a fanshaped way from the upper end of the apophysis; this net is covered with numerous small thorns, especially towards the point. Also the upper edge of the apophysis is very broad and full of holes. (The figures in the «Challenger»-Echinoids, Pl. XLIV, 6—14, are not very good, especially not figs. 6 and 11, where it is not seen at all that the whole mass filling the blade, is really a net of meshes with innumerable larger and smaller holes). In the other, smaller form the apophysis has the common structure; the blade is highly compressed, deep, and filled with an irregular net of meshes where the holes are not at all serially arranged. Transitions are however found between the two forms, so that they cannot be said to be two distinct kinds. When Agassiz (Chall. Ech. p. 43) says of the large-headed, shortstemmed pedicellariæ that they are «very similar to those of *Dorocidaris*», this is only so far correct, as tridentate pedicellariæ, of course, always in some degree resemble each other; in the finer structure the large tridentate pedicellariæ of this species are especially widely different from those of *D. papillata*. The small ones are much more similar. — Agassiz (l. c.) mentions one more form of pedicellariæ, «shortstemmed globular abactinal pedicellariæ» (Pl. XLIV, 10); they are, as I have been able to substantiate, only developmental forms of the large tridentate pedicellariæ. I am a little in doubt whether globiferous pedicellariæ are found. In my preparation of isolated skeleton-pieces of pedicellariæ of this species is seen one valve of a small globiferous pedicellaria, which is very peculiar, with two large teeth at the point, and a rather small opening surrounded by well developed teeth (Pl. IX, Fig. 2). As, however, only one such valve is found, it may be thought to have come in by chance; in this case it must be abnormal, as no other Cidarid examined by me, is possessed of such pedicellariæ. For the present this must be left undecided. — It is obvious that this species has no relation with *P. purpurata*, and as it shows no nearer relation to any other known species, it must form a separate genus, for which I propose the name of **Histocidaris.**

P. Sharreri: Agassiz (9) unfortunately gives no details as to the pedicellariæ, and from the figure (op. cit. Pl. III) it cannot be decided whether it is a genuine *Porocidaris*. There seems to be no highly developed neck on the spines (in the text nothing is said of this feature); the pedicellariæ might well look like those of *P. purpurata*, but a close examination will be necessary for the decision. By the kindness of Prof. Rathbun I have from U. S. National Museum received a specimen determined as *P. Sharreri* («Albatross» 1885. St. 2415); it proved to be the new species *Stereocidaris ingolfiana* described hereafter; it has no relation to *P. Sharreri*. Further I have in British Museum seen a specimen determined as *P. Sharreri*, from U. S. Fish Commission («Albatross» 1885. St. 2345). Neither seems this specimen to be identical with the real, figured *P. Sharreri*, at all events it does not to any striking degree resemble the figure given by Agassiz. It is no *Porocidaris*. The pedicellariæ (Pl. IX, Fig. 26) are much like those of *Dorocidaris*, only the opening of the large globiferous pedicellariæ is more round and of a more definite form than is otherwise the case in this genus; but this fact might very well be interpreted as a specific difference. Tridentate pedicellariæ simple. A much more considerable difference is found in the spines; they are long, slender — unfortunately they were broken, so that their length and the form of their point are unknown. The base is finely pink, the outer part white. They are quite smooth and shining, as if polished, and the structure of the outer layer

is peculiar (Pl. XI. Fig. 24) with no trace of roughness on the surface. Perhaps the specimen of *Porocidaris Sharreri* mentioned by Agassiz (9 p. 13) which was of a light greenish pink color when alive, the spines white with a delicate brownish-pink base is identical with the specimen described here — in this case this specimen mentioned by Agassiz has certainly not been of the same species as the one he figures; but this latter must, of course, keep the name of *Sharreri*. There can be no doubt that the specimen described here is a new species; whether it also is to be regarded as a new genus, or belongs to *Porocidaris*, can only be decided, when the systematic significance of the spines has been established. For the present it ought to be classed with *Porocidaris*, under the name of **D. micans** n. sp.

Neither is *P. incerta* Koehler (233 a), of which species Prof. v. Beneden has lent me a specimen for examination, a *Porocidaris*. I have only found one form of globiferous pedicellariæ on it; it has no end-tooth, the opening small, round (Pl. VIII, Fig. 31). Most likely another, larger form of globiferous pedicellariæ will be found in this species; but the figured form is a sufficient proof that this species has no relation to *Porocidaris*. Koehler also refers it only in a doubtful way to *Porocidaris* on account of the highly dentate actinal radioles. The spicules are simple.

Of the other species that have been referred to *Porocidaris*, *P. Cobosi* most likely is a genuine *Porocidaris*, but it cannot be decided with certainty, till the pedicellariæ have been examined. For the present nothing can be said with certainty of *P. Milleri* and *misakiensis*; according to Agassiz (13) *P. Milleri* is «closely allied to *P. elegans*». On the other hand it may be said with certainty that *P. gracilis* Döderl. is no *Porocidaris*. Its globiferous pedicellariæ of which only one form is known, recall to some degree those of *Goniocidaris canaliculata*; tridentate pedicellariæ unknown. Perhaps it ought to form a separate genus.

The genera *Stereocidaris* and *Goniocidaris* to which a whole series of species have been referred, are still left. The species referred to *Stereocidaris: japonica, grandis, sceptriferoides*, and the here described new species *St. ingolfiana* agree in the structure of the pedicellariæ: there is no end-tooth, and the large opening reaching to the very point is broad and well limited below, quite narrow above. The small globiferous pedicellariæ chiefly of the same structure, without end-tooth; the tridentate pedicellariæ seem to show no special peculiarities (they are not known in all the species). The spicules are rather large fenestrated plates, not thorny bows, as is else the case in the Cidarids — this, however, does not apply to all the species; in *St. grandis* they are of the common form, and so the spicules give no reliable generic character. There is no reason to doubt that also *St. indica* Döderl. really belongs to this genus, although we have no informations of its pedicellariæ. Döderlein further thinks (118) that *Porocidaris tiara* and *alcocki* are perhaps only local forms of this species. Of the species *St. tenuispinus* and *microtuberculatus* Yoshiw. nothing can be said with certainty. — Whether this group of species really belongs to the same genus as the fossil *Stereocidaris*-species, cannot be definitely decided, until the pedicellariæ of the latter are known; but the probability is that they really belong here, and there is no reason, at all events not for the present, to reject the name of *Stereocidaris* for them.

To the genus *Goniocidaris*, the only one of the hitherto admitted genera that has been commonly acknowledged, the following species have been referred: *geranioides* Lamk., *tubaria* Lamk.,

canaliculata Ag. (to which *Cidaris nutrix* W. Th., *Gonioc. vivipara* Studer, and *G. membranipora* Studer are referred as synonyms), *florigera* Ag., *Döderleini* Ag., *biserialis* Döderl., *clypeata* Döderl., *umbraculum* Hutton, and *Mortenseni* Koehler. Types of this genus are the species *geranioides* and *tubaria*, especially peculiar by having rather deep pits between the plates, in each of which pits is placed an almost globular pedicellaria. These pedicellariæ are very peculiar, short and broad; the opening, which is small and surrounded with distinct teeth, reaches to the point, so that no end-tooth is found (Pl. X, Fig. 20). The small globiferous pedicellariæ have a powerful end-tooth; no tridentate pedicellariæ seem to be found. Spicules of the common form. There can be no doubt that *G. geranioides* has the same structure of the pedicellariæ as *G. tubaria*; the large globiferous ones are figured by Agassiz (Revision Pl. XXIV, 12—13), and they are obviously very similar to those of *tubaria*. Perrier (op. cit. Pl. III, 12) figures a small globiferous pedicellaria, but the figure gives no clear information of the structure of the point; the text, however, leaves no doubt that it is built as in *G. tubaria*. Most closely allied to these two species is no doubt *G. umbraculum* Hutton. The pedicellariæ (Pl. X. Figs. 13, 21) show only little difference from those of the two mentioned species. Also *G. biserialis* Döderl. belongs here; to be sure, it is not clear from the figures and description of Döderlein, in what way the small globiferous pedicellariæ are constructed, but Prof. Döderlein has kindly sent me a preparation, so that I have been able to substantiate that they are built as in the other species, with a powerful end-tooth (Pl. IX, Fig. 10). The two species *G. clypeata* and *mikado* are especially distinguished from the other *Goniocidaris*-species by the spines being highly widened, and having, moreover, a peculiar basal widening; the impressions in the angles of the plates are indistinct; the pedicellariæ seem also to be somewhat different from those of the typical *Goniocidaris*-species, although agreeing with them in main features (no end-tooth on the large pedicellariæ, an even uncommonly powerful one on the small ones). Thus there seems to be every reason to comprise these species in a separate subgenus, *Discocidaris*, as proposed by Döderlein (114). Döderlein thinks that *G. florigera* must be referred to the same group, especially because it also shows the basal widening on the spines, although only as a trace. It has long been doubtful to me, whether the two forms figured by Agassiz as *G. florigera* (Chall. Ech. Pl. I. Figs. 7 and 12), were really the same species, and my doubt was confirmed, when I had examined the type-specimens in British Museum. They are not only two different species, they will even undoubtedly have to be referred to two different genera — and moreover it appeared that among the specimens determined as *G. florigera* still a third form was hidden, which must also form a new genus. The form meant by Döderlein when he places *G. florigera* together with *clypeata* and *mikado*, is the one figured in Fig. 12; it is this form of which the spines show traces of the basal widening. It has already been mentioned above, and a new genus has been established for it: *Petalocidaris*, its pedicellariæ not admitting it to be referred to any of the other known genera. Otherwise it is presumably most closely allied to the two mentioned species. The other form, which is figured in Fig. 7, shows no basal widening on the spines, which are, upon the whole, very much different from those of *Petalocidaris*; they are highly and rather regularly thorny, evenly tapering. In none of the three specimens (Chall. St. 204) I have examined, large globiferous pedicellariæ were found, but only the small form, which is quite similar to the small pedicellariæ of *Discocidaris* (Pl. X. Figs. 6—7); for the present

therefore, I think it better to refer it to this subgenus; the spines, to be sure, show no trace of the widenings peculiar to the two other species, but the not widened spines of the latter are rather similar to those of this species, for which I propose the name of **Discocidaris serrata** n. sp.

From st. 192 (Chall.) a specimen is found referred by Agassiz to *G. florigera*, which it also resembles rather well (i. e. it resembles the one figured in Fig. 12, *Petalocidaris florigera*). The spines are much richer thorny than in this species; the ambulacral areas almost naked. The pedicellariæ are very peculiar (Pl. X. Figs. 25, 28). The opening is a long, narrow slit reaching not quite to the point; a powerfully developed end-tooth is found. The small pedicellariæ are essentially of the same structure, the opening only being somewhat shorter and a little broader. Such pedicellariæ have not been found in any of the other known species, and accordingly this species must form a separate genus, for which I propose the name of **Schizocidaris** with the species **Sch. assimilis** n. sp.[1]).

According to Agassiz (Chall. Ech. p. 43 seq.), *Goniocidaris canaliculata* is exceedingly varying; he thinks that *Cidaris nutrix* W. Th. must be regarded as one of the many forms of this species, and also that *G. vivipara* and *membranipora* are synonymous with it. After having examined the specimens of *G. canaliculata* in British Museum I must admit that it really appears as if they all formed only one highly varying species, in which a great number of transitional forms connect the easily recognised extreme forms. If we examine the pedicellariæ, we shall get another conviction; we shall then see that at all events three different species are found among these specimens referred to *G. canaliculata*. There is a fact that ought to have made Agassiz hesitate in referring them all to one species. He quotes the description by Wyv. Thomson (397) how the eggs of *C. nutrix* «are passed along on the surface of the test towards the mouth, and the smaller slightly spathulate primary spines, which are articulated to about the first three rows of tubercles round the peristome, are bent inwards over the mouth, so as to form a kind of open tent, in which the young are developed». Immediately after this quotation Agassiz (op. cit. p. 45) says: «The specimen (Pl. II. fig. 2) shows the manner in which they are held in a sort of marsupium by the folding of the abactinal spines over the young crowded upon the abactinal system». Thus in this species not only a nursing of the brood should take place, but the young should even be placed, now round the mouth, now on the apical area. Even if this were not inconceivable, it would have been worthy of remark; but Agassiz has no word of it, though it might seem to imply that *Cidaris nutrix* is really specifically different from *Gonioc. canaliculata*. Wyv. Thomson (397 p. 66) also remarks expressly that in *G. canaliculata* we have the reverse of the fact in *C. nutrix*: «These spines ... lean over towards the anal opening, and form an open tent for the protection of the young as in *Cidaris nutrix*, but at the opposite pole of the body». There is also another fact that ought to raise the suspicion against the interpretation of all these forms as one species: most of the specimens are coast-forms, taken on depths of 3—150 fathoms; from this there is a far cry to a depth of 1600 fathoms and more. Beforehand it is very improbable that the same species should be found in so varying depths. This fact is not mentioned by Agassiz either. According to my examinations *Cidaris nutrix* is specifically different from *G.*

[1]) Unfortunately I made no more thorough notes on this specimen, as during my stay at Br. Mus. I had no clear understanding of the fact that it was a genus quite different from the other specimens called *G. florigera*. I did not get a clear view of this fact till after my return, when I had examined the pedicellariæ more exactly. The peculiar pedicellariæ may, however, be sufficient for the identification of the species, and therefore I do not hesitate to give it a name here.

canaliculata; among the deep-sea forms at all events one new species is found, and upon the whole scarcely any genuine *G. canaliculata* is found among them.

In the typical *G. canaliculata* the large globiferous pedicellariæ do not differ much from those of *Goniocidaris tubaria*, or still less from those of *G. umbraculum*; they are somewhat narrower, and the blade is a little curved inward below the rather large opening that reaches to the point; there is no end-tooth (Pl. VIII. Figs. 8, 32). The small pedicellariæ, on the other hand, are very different from those of the genuine *Goniocidaris*-species, as there is no end-tooth (Pl. VIII. Fig. 6). Spicules simple. — The young are carried on the apical area. «*Cidaris*» *nutrix* (Wyv. Thomson's type specimen examined): the large pedicellariæ (Pl. X. Figs. 3—4, 12, 14) very much resembling those of *Stereocidaris grandis* (Döderlein 116. Pl. VIII. 2); the small globiferous ones (Pl. X. Fig. 24) chiefly as in *G. canaliculata*. — The young are carried round the mouth.

The two species are most frequently easily distinguished as to their habitus. In *C. nutrix* the apical area is densely set with rather long, club-shaped spines, between which large pedicellariæ are found abundantly. In *G. canaliculata* the apical area is set with rather few and scattered, not club-shaped spines some of which are quite small, so that the area looks rather naked; generally no pedicellariæ are found on the apical area. This difference, however, is not absolutely reliable, and without the pedicellariæ the two species are not always to be distinguished with certainty.

It is evident that these two species cannot be referred to the genus *Goniocidaris*; especially the small pedicellariæ are different from those of *Goniocidaris*, as they have no end-tooth. Döderlein (116. p. 18) thinks *G. canaliculata* to be nearly allied to *Dorocidaris*; to be sure it occupies an extreme position in the *Dorocidaris*-group, and perhaps it might also be regarded as the only representative of a special group. In many respects it recalls the «*Eucidaris*»-group. Wirklich nahe Beziehungen zu einer der bisher bekannten Arten von Cidariden bietet diese Form jedenfalls nicht dar». — As has already been mentioned, the pedicellariæ of *C. nutrix* are very similar to those of *Stereocidaris grandis*, and these two species would seem to have to be referred to the genus *Stereocidaris*; at all events there seems to be no objection of consequence to their being referred to this genus, and it might be difficult to point out a character, which would necessitate the establishing of a special genus for these species. The simple spicules are in accordance with those of *St. grandis* (in the other *Stereocidaris*-species they are, as mentioned, large fenestrated plates).

Of the species «*Goniocidaris*» *vivipara* and *membranipora* the former (according to Studer, 386) is synonymous with *G. canaliculata*, which statement I am able to corroborate from the examination of a specimen that our museum has received from the museum at Berlin. The other (also according to examination of specimens from the museum at Berlin) is identical with «*Cidaris*» *nutrix* W. Th., as has already been supposed by Studer (385). As the paper by Wyv. Thomson (397) bears the date of June 1st 1876, and that of Studer (384) the date of July 27th 1876, the name of *nutrix* has the priority. Now we meet here with a new difficulty. Studer says of *G. membranipora* (384 p. 455): «Die jungen *Cidaris* bleiben auf dem Analfelde der Mutter bis zu ihrer völligen Entwicklung, von den obern Stachelreihen geschützt, die sich kreuzweise darüber legen». According to this statement this species would seem nevertheless to carry the young now arround the mouth, now on the apical area. As this seems to me to be very improbable, I must suppose a mistake to have taken place, so that

the specimen (or specimens?), which Studer has had, with young ones on the apical area, is not *G. membranipora* (= *nutrix*), but *canaliculata*, and then it is scarcely from Kerguelen (comp. the following about the occurrence of these two species). When the pedicellariæ are not examined — which has evidently not been done by Studer — it is, as has been stated above, not always to be decided with certainty, to which of the two species a specimen in hand belongs; this will especially hold good, when, as the case has been here, the apical area is not to be seen.

Among the rather numerous specimens of these two species examined by me (from Challenger at British Museum), *St. canaliculata* was only taken at the Falkland Islands and a station near those islands, Chall. st. 315, *St. nutrix* only at Kerguelen. Some specimens from st. 150 (Chall.) near Kerguelen, 150 fathoms, have pedicellariæ as those of the typical *St. nutrix* but the spines are much longer, three times the diameter of the test; perhaps it is a separate species. Wyv. Thomson (397) mentions *C. nutrix* from Kerguelen, *G. canaliculata* from the Falkland Islands. In the same way Studer's *G. vivipara* (= *canaliculata*) is from Patagonia, his *G. membranipora* from Kerguelen. Thus it would seem that these two species do not occur together; *St. canaliculata* is found at the southern coasts of South America, *St. nutrix* at Kerguelen. Agassiz, to be sure, mentions *St. canaliculata* from several other localities at Kerguelen, but according to what is shown here his statement is not to be relied upon. Until a definite proof of the opposite fact comes forth, I must believe that either of these species has a territory of its own, as represented here.

Among the deep-sea specimens referred by Agassiz to *G. canaliculata*, I have only examined two from Chall. st. 156 (the South Polar Sea, 1975 fathoms). No doubt they represent another species. The large globiferous pedicellariæ (Pl. VIII, Fig. 35) recall very much those of the *Goniocidaris*-species, but the small ones are like those in *canaliculata* and *nutrix*; and thus it would seem that this species must also be referred to *Stereocidaris*. The ground-colour is very dark, almost black; the primary spines are white, the actinal ones highly indented in the edge. Perhaps it may prove to be identical with «*Porocidaris*» *incerta* Koehler. I have not examined the specimens from st. 147 (1600 fathoms) and 153 (1675 fathoms), but that they are not identical with *St. canaliculata* or *nutrix*, which live on shallow water, may be said a priori with a great deal of probability.

Goniocidaris Mortenseni Koehler. Koehler (233 a) in his excellent description of this species mentions only one form of pedicellariæ with «ordinairement un ou deux crochets plus ou moins marqués» at the point of the valves. This statement does not give sufficiently clear information, neither does the figure of a whole pedicellaria given by Koehler show the systematically important structures in a sufficiently exact way. Prof. v. Beneden has most kindly sent me a couple of specimens for examination, so that I am able to supply the informations wanting, and assign to this uncommonly fine and characteristic species its place in the system. The large globiferous pedicellariæ have no end-tooth; they are quite similar to those of *Stereocidaris nutrix*, so that I can simply refer to the figures of the latter. The small globiferous pedicellariæ are rather characteristic (Pl. VIII, Fig. 34); they have no end-tooth, and the opening is small; they recall those of «*Porocidaris*» *incerta* very much. The spicules simple. Accordingly this species is no *Goniocidaris*, but will probably have to be referred to the genus *Stereocidaris*, to which genus perhaps also «*Porocidaris*» *incerta* ought to be referred.

Of the other species referred to *Goniocidaris*, *G. Döderleini*, according to Agassiz, is most nearly allied to *canaliculata*; nothing, however, can be said with certainty, till its pedicellariæ have been examined.

Phyllacanthus australis Ramsay is still to be mentioned. As to its place in the system can for the present only be said that it belongs scarcely to the genus *Phyllacanthus* as limited here; where it is else to be referred we can only learn when its pedicellariæ have been examined.

According to the researches reported here the system of the Cidarids will look as follows:

Dorocidaris A. Ag. (emend.).

Large globiferous pedicellariæ with well-developed end-tooth; the opening large, rounded or irregular below, not reaching the point. No limb on the stalk. Small pedicellariæ with end-tooth; tridentate pedicellariæ simple; spicules simple.

Species: *D. papillata* (Leske), *Blakei* Ag., (?) *micans* n. sp.

Distribution: The Northern Atlantic, the Mediterranean. Sublittoral-archibental forms[1]).

Tretocidaris n. g.

Large globiferous pedicellariæ with powerful end-tooth; the opening a quite small pore rather far from the point. A limb on the stalk, more or less developed. Small pedicellariæ like the large ones, only with a somewhat larger opening. Tridentate pedicellariæ simple; spicules simple.

Species: *T. Bartletti* (A. Ag.), *annulata* n. sp., *spinosa* n. sp.

Distribution: The warm regions of the Atlantic. Littoral(?)-sublittoral forms.

Stephanocidaris A. Ag. (emend.).

Large globiferous pedicellariæ much lengthened and slender with distinct end-tooth; the opening rather small, triangular, a little below the point. No limb on the stalk. Small pedicellariæ of the same structure; tridentate pedicellariæ simple. Spicules simple.

Species: *St. bispinosa* (Lamk.), *annulifera* (Lamk.), *bracteata* (Ag.).

Distribution: The Indian Archipelago, Australia. Littoral-sublittoral forms.

Schizocidaris n. g.

Large globiferous pedicellariæ with distinct end-tooth; the opening a long, narrow slit. No limb on the stalk. Small pedicellariæ like the large ones, only the mouth a little shorter and broader. Tridentate pedicellariæ? Spicules?

Species: *Sch. assimilis* n. sp.

Distribution: Near New Guinea (Chall. st. 192). Sublittoral.

Cidaris Klein (emend.).

Large globiferous pedicellariæ with small terminal opening; the blade somewhat prolonged in a snout-shaped way. No end-tooth. A more or less developed limb on the stalk. Small pedicellariæ with well developed end-tooth and large, not terminal opening. Tridentate pedicellariæ simple Spicules simple.

[1]) In the present work distinction is made between the littoral belt, the sublittoral, archibental, and abyssal belt. The first is reckoned from 0 –ca. 50 fathoms, the second from ca. 50—ca. 300 fathoms, the third from ca. 300—ca. 1500 fathoms; greater depths are called abyssal. It is impossible to fix the limits between these regions more exactly.

Species: *C. affinis* Phil., *Reini* Döderl., *tribuloides* Lamk., *galapagensis* Döderl., *metularia* Lamk., *Thouarsii* Val., *verticillata* Lamk., *baculosa* Lamk.

Distribution: Cosmopolitan in the warm seas; the Mediterranean, Japan. Littoral-sublittoral forms.

Chondrocidaris A. Ag.

Large globiferous pedicellariæ with large, cordate opening, the lower limit of which forms a projecting lip; the opening reaches the point; no end-tooth; no limb on the stalk. Small pedicellariæ with a more or less developed end-tooth. Tridentate pedicellariæ simple (rather highly dentate). Spicules simple.

Species: *Ch. gigantea* A. Ag.

Distribution: The Sandwich Islands, Mauritius. Littoral.

Acanthocidaris n. g.

Large globiferous pedicellariæ with large opening, irregularly limited below and reaching the point; no end-tooth; no limb on the stalk. Small pedicellariæ of the same structure as the large ones. Tridentate pedicellariæ with delicate, dentate lamellæ in the blade. Spicules simple. The spines long, compressed, curved.

Species: *A. curvatispinis* (Bell).

Distribution: Mauritius. Littoral (?).

Stereocidaris Pomel.

Large globiferous pedicellariæ with large opening reaching quite to the point; no end-tooth; no limb on the stalk. Small pedicellariæ of the same structure, without end-tooth. Tridentate pedicellariæ simple. The spicules often larger, fenestrated plates; in some species simple.

Species: *St. japonica* Döderl., *grandis* Döderl., *sceptriferoides* Döderl., *indica* Döderl., *ingolfiana* n. sp., *nutrix* (Wyv. Thoms.), *canaliculata* (A. Ag.), *Mortenseni* (Koehler), (?) *incerta* (Koehler).

Distribution: Cosmopolitan. Littoral-archibental forms.

Goniocidaris Desor.

Large globiferous pedicellariæ with rather small opening reaching the point; no end-tooth. The valves very short and broad. No limb on the stalk. Small pedicellariæ with powerful end-tooth. Tridentate pedicellariæ seem not to be found. Spicules of the common form. The spines more or less irregularly widened. The test with deep impressions in the angles between the plates.

Species: *G. tubaria* (Lamk.), *geranioides* (Lamk.), *biserialis* Döderl., *umbraculum* Hutton.

Distribution: Australia, Japan. Littoral-sublittoral forms.

Subgen. **Discocidaris** Döderl.

Pedicellariæ chiefly as in *Goniocidaris*. The spines most frequently much widened at the point and with basal widening.

Species: *D. clypeata* Döderl., *mikado* Döderl., (?) *serrata* n. sp.

Distribution: Japan, the Philippine Islands. Sublittoral forms.

Petalocidaris n. g.

Large globiferous pedicellariæ with small terminal opening, the blade somewhat elongated.

No end-tooth; no limb on the stalk. Small pedicellariæ with end-tooth and large, not terminal opening. Tridentate pedicellariæ ?, spicules ?. Spines extended in a more or less flower-like way, trace of basal widening.

Species: *P. florigera* (A. Ag.).

Distribution: The Philippines (Chall. st. 204) (or New Guinea; Chall. st. 192). Sublittoral.

Phyllacanthus Brandt (emend.).

Synonym: *Leiocidaris* Desor.

Large globiferous pedicellariæ with small terminal opening; no end-tooth; the blade prolonged in a snout-like way. Limb on the stalk? Small pedicellariæ with end-tooth. Tridentate pedicellariæ with the blade filled by a close reticulation forming irregular longitudinal ridges closely set with teeth. Spicules simple. Spines large and thick, finely striated.

Species: *Ph. imperialis* (Lamk.), (?) *dubia* Brandt, (?) *parvispina* Woods.

Distribution: The Red Sea, the Indian Ocean, Australia. Littoral forms.

Histocidaris n. g.

Large globiferous pedicellariæ unknown; small pedicellariæ with two rather strong end-teeth (?). Tridentate pedicellariæ of a larger and a smaller form; the blade of the large ones is filled by a rich net of meshes, the holes of which are rather distinctly arranged in series, and radiate in a fan-shaped way from the upper end of the apophysis; numerous small thorns on the inner surface of the blade, especially towards the point; also the apophysis is broad and full of holes. The smaller form simple. Spicules simple. Spines long and slender.

Species: *H. elegans* (A. Ag.).

Distribution: Australia (New Guinea, the Philippines). Archibenthal.

Porocidaris Desor.

Only large two-valved pedicellariæ. The spines with very long neck. Spicules simple.

Species: *P. purpurata* W. Thoms.

Distribution: The Northern Atlantic. Archibenthal.

Incertæ sedis:

Dorocidaris panamensis Ag.
— *tiara* Anderson.
— *alcocki* —
Stereocidaris tenuispinus Yoshiw.
— *microtuberculatus* Yoshiw.
Porocidaris misakiensis —
— *Sharreri* Ag.
— *Milleri* —
— *Cobosi* —
— *gracilis* Döderl.
Phyllacanthus australis Ramsay.
Goniocidaris Döderleini Ag.

When in the diagnoses of genera given here other features than pedicellariæ and spicules have only been mentioned exceptionally the opinion of course is not that these structures should be sufficient for definitive diagnoses. It has already been emphasized above, and I shall here emphasize once more that all features must be thoroughly examined in order to get the mutual relations of the forms established. That I have here only treated the pedicellariæ more thoroughly is a consequence of the fact that neither my material nor my time has permitted me to treat the other features more particularly. The system of the Cidarids cannot get its definitive formulation, until all features have been examined in a greater number of species (or best in all species). What is given here is a provisional classification, which can scarcely be correct throughout, but it has the great advantage of the earlier systems that it is possible to recognise the genera with certainty. Several things, moreover, indicate that the genera, at all events most of them, have here been correctly interpreted. The species referred to the same genus are upon the whole of similar appearance, so that the genera may in most cases be recognised by their habitus alone. Also the distribution seems to become more clear by the grouping given here. — Whether the genera may be grouped in larger divisions — subfamilies — cannot be decided at present. In the structure of the pedicellariæ there seems only to be a single feature that might possibly be of some importance for such a grouping, viz. whether the large globiferous pedicellariæ have an end-tooth or not. Whether this feature is of so great importance, can only be decided, when the necessary thorough examinations have been made.

1. **Dorocidaris papillata** (Leske).

Pl. V, Figs. 6, 7, 8. Pl. VIII, Figs. 1, 3, 12, 14, 27. Pl. IX, Figs. 3, 5, 7, 13—15, 20, 25, 27. Pl. XI, Figs. 14, 26, 31.

Main synonyms: *Cidaris papillata* Leske.
— *hystrix* Lamk.
— *borealis* Düb & Kor.
Dorocidaris abyssicola A. Ag.

Non: *Cidaris affinis* Phil.

Principal literature: Sv. Nilsson & A. L. Holst: Collectanea Zoologiæ Scandinaviæ. 1817. p. 11. — Düben & Koren: Öfversigt af Skandinaviens Echinodermer. Kgl. Vetensk. Akad. Handlingar för år 1844. Stockholm 1846. p. 255. T. IX. 25—30. — M. Sars: Bidrag til Kundskaben om Middelhavets Littoralfauna. 1857. p. 109. Oversigt af Norges Echinodermer. 1861. p. 93. — A. Agassiz: Revision of Echini. Part. II. p. 254. Pl. I. etc. »Challenger»-Echinoidea (8). p. 38. Blake -Echinoidea (9). p. 12. — Wyv. Thomson: Echinoidea of Porcupine (395). p. 722. Pl. LIX. 1—13. — V. Gauthier: 160. — R. Koehler: 217. p. 113. — H. Prouho: 327. — R. Rathbun: 336. p. 611. — C. Stewart 379. — E. A. Verrill: 418. — W. E. Hoyle: Revised List of British Echinoidea. (202). p. 404. — F Jeffr. Bell: Catalogue of British Echinoderms. 1872. p. 139. 69.

With regard to the great number of other works in which this species is noticed or more particularly mentioned, reference may be made to Agassiz's Revision of Echini, Bell's Catalogue, and Ludwig (256); there complete lists of synonyms are also given.

This species has been so often mentioned and partly carefully described, that I do not think there is any reason to describe it here again; so I shall only make some observations with regard to a few separate features that have not before been described with sufficient exactness, viz. the arrangement of the tubercles, the pedicellariæ, the spicules, and the structure of the spines.

The interambulacral area: Round each areole there are nearest to the edge about 15 small tubercles with distinct articular head, and outside of these a new circle of tubercles a little smaller and situated in the intervals between the inmost ones. Outside of these are found more or fewer small tubercles according to the size of the animal, decreasing in size inward towards the median line of the area and outward towards the adjoining ambulacral area. The tubercles do not reach quite to the median line or to the pore area; a little naked space is left, and this — at all events in larger specimens — is furrowed by irregular transverse furrows crossing the median line from one plate to the other as also the line of separation between the ambulacral and the interambulacral area; the latter correspond rather exactly to the lower end of each ambulacral plate. The edges round the highly depressed areoles are high, the plates slope rather abruptly down towards the median line and outward towards the pore area (Pl. VI. Fig. 7).

The ambulacral area (Pl. VI. Fig. 8). Inside the pores a little tubercle is found on each plate; these tubercles form a fine, regular row down each side of the ambulacral area, as is commonly the case in the Cidarids; the primary series it is here called. Inside of this series still a smaller tubercle is commonly found on each plate, just opposite to the outer one; nearest to the apical area and the peristome the inner tubercle is commonly found only on one side, alternately — but irregularly — to the right and the left, and sometimes there is all the way down only a single series of these secondary tubercles. In young specimens they are only found on the middle part of the area, and only a single series; sometimes the small spines of these tubercles in the median line of the area raise perpendicularly; generally they lie over or between the bases of the primary ambulacral spines. — It is, no doubt, for want of place that these secondary tubercles appear only in a single series in small individuals and on the narrow actinal and abactinal end of the area in large individuals. It is especially on the base of these spines that the peculiar, gland-like «ampulla» (Pl. VIII. Fig. 14) is found highly developed, which has been more nearly examined by Prouho (327. p. 56) and Hamann (184. p. 28). It is also often much developed on the spines of the apical area.

A transverse section of the large spines (the «radioles») (Pl. XI, Figs. 14, 31) shows that in the intervals between the crests the outer layer runs out in short, branched thorns that coalesce and form a coarse reticulation. There is no reason to describe the form of the spines here anew.

Although the pedicellariæ of this species have been figured several times, I nevertheless think it necessary to figure and describe them anew. Perrier's figures are neither good nor exact; the same may be said of the figures given by Agassiz (Revision of Echini. Pl. XXIV) and Koehler (217. Pl. 7) — neither of them give an exact representation of the finer structures that are of systematic importance. Stewart (379) on the other hand has given some excellent figures of the large globiferous pedicellariæ, and Wyv. Thomson (395) gives rather good figures of the small globiferous pedicellariæ and of the tridentate ones. — I think it unnecessary to give a full description of the pedi-

cellariæ, and therefore I only mention the features being of systematic importance; for the rest the reader is referred to the figures (Pl. VIII. Fig. 27. Pl. IX. Figs. 3, 5, 7, 13—15, 20, 25, 27).

At the point of the large globiferous pedicellariæ (Pl. IX, Fig. 3, 5) is found a distinct tooth separated from the opening on the inside of the blade by a distinct curve; seen from the inside it appears as a long narrow point before the upper edge of the opening. A canal is seen to run through this point, and open on the upper side of the tooth — this canal is the efferent duct from the poison- or mucous gland enclosed by the blade. The inner opening is large, lengthened, most frequently running into a narrow point below. The edge round the opening is more or less thickened, with numerous small teeth and a few large ones placed irregularly. The outside of the blade is highly and irregularly perforated almost to the very point. The stalk of these and of the other pedicellariæ consists of a highly irregular, complicated calcareous network, with no conspicuous free points (limb) at the transition between the thick and the thin part. The length of the head is about 1^{mm}; the length of the stalk is somewhat different, but generally it is very short, even shorter than the head. They are found especially on the apical area, but also in the interambulacral areas, mostly on the naked spaces.

The small globiferous pedicellariæ (Pl. IX. Figs. 13—15, 20) are upon the whole constructed as the large ones; the tooth at the point is considerably smaller, may be very slightly developed. The inner opening is comparatively larger than in the large globiferous pedicellariæ; the lower edge may also here be irregular. They are more long-stalked and upon the whole much more slender than the large ones. They are especially found among the small spines round the radioles and on the peristome, but may otherwise be scattered over the whole test.

The tridentate pedicellariæ (Pl. IX. Figs. 7, 25, 27) are large and slender: the head is $1—2^{mm}$ long, the length of the stalk is very differing, but commonly it is considerably longer than the stalk of the large globiferous pedicellariæ. The blades are narrow, straight, and join close together in their whole length, when shut, or are at all events only apart for a very little space below. The edge is somewhat thickened and highly dentate; at the transition between the base and the blade the edge is often very irregularly serrate. The blade is narrow and deep, filled by an irregular network, which is often, in the lower part of the blade, provided with fine teeth; in the outer part of the blade most frequently only cross-beams are found connecting the edges with each other. These pedicellariæ are especially found in the middle of the ambulacral areas towards the mouth. In some individuals they seem to be quite wanting.

The spicules of the tube feet (Pl. XI. Fig. 26), as is known from Perrier and Wyv. Thomson, are bow-shaped and rather highly thorny. They are situated in two series in the skin of the tube foot, so as to join each other along one side of the foot — not, however, in a definite line, the ends catching irregularly in between each other. On the other side they are widely scattered; thus the tube-foot is closely mailed for $^3/_4$ or $^2/_3$ of its circumference, the other part is naked (Pl. VIII. Fig. 1). The naked side seems always to be the oral one; in this side the tentacle-nerve is lying, as shown by Prouho (op. cit.). Otherwise he also gives a quite correct description of the way in which the spicules are arranged in the tube-feet. — Down towards the base of the tube-foot the spicules become shorter and less thorny, and here they do not join on either side, and are thus arranged in two com-

pletely separated series. Towards the sucking disk they become larger and more thorny, at last highly complicate; the arcuate ground-form may, however, always be distinguished. They may here join on both sides, so that the foot is completely mailed.

Together with Agassiz, Ludwig, Koehler, Bell, a.o. I think it unquestionable that the Mediterranean form *C. hystrix* Lamk. is identical with this species. The only definite character found by Philippi and Sars for distinguishing between this latter and *D. papillata* is the fact that in the latter there are 16—18 raised, dentate, longitudinal ridges on the spines, in *C. hystrix* only about 12. As, however, in the same individual, as well of the northern form as of the Mediterranean one, some spines may be found with 12—13 ridges, and others with 16—17 such, this character is useless. It may be possible that the spines in the Mediterranean form are somewhat longer and slenderer than in the northern form; the tridentate pedicellariæ seem also to be somewhat more dentate in the edge than those of the northern form. I think that it may at most be regarded as an only little marked variety of *D. papillata*.

Dorocidaris abyssicola Ag. has by Agassiz himself been referred to *D. papillata* as a synonym; whether it may possibly be kept as a separate species, or at least a variety I am not able to decide from my material (one specimen from U. S. Fish Comm., and one from Mus. Comp. Zool.); it might, however, seem as if the small globiferous pedicellariæ might yield a character tending this way (Pl. IX. Fig. 14). — In «Revision of Echini» p. 256 Agassiz mentions a variety of *Doroc. papillata* with slender, highly dentate spines. Also Rathbun (op. cit. p. 611) mentions this variety. Our museum has received some specimens of this form from U. S. National Museum. A closer examination shows that it has nothing to do with *D. papillata*, it is *Cidaris affinis*, or a variety of this species.

Dorocidaris papillata is spread over the northern Atlantic and the Mediterranean; for the present it cannot be said how far south it reaches, nor can it be decided to how great a depth it is found. As there has proved to be a great uncertainty in the earlier determinations of Cidarids, and as especially a widely different species, even from a quite different genus, viz. *Cidaris affinis*, has generally been confounded with *D. papillata*, all the statements in literature as to its occurrence are not to be relied on with certainty. Only so much may be said of its distribution in the Atlantic that it is found along the coasts of Norway on depths from 100—200 fathoms, at the Shetland Islands, but not farther south in the North Sea, south of Iceland (Ingolf), at the Atlantic coasts of Great Britain, and presumably at the coasts over the whole of the North Atlantic, as well at the European side as at the American side (Florida). On the other hand it is not found in the territories of the North Atlantic where the bottom temperature is negative (the «cold area»). In Bell's Catalogue the depth is given to from 0—874 fathoms. This is scarcely correct; it seems to be found on no smaller depth than 30—40 fathoms. Wyv. Thomson (op. cit. p. 725) states that he has some small specimens from ca. 1000 fathoms. *D. papillata* is no abyssal form, it seems mostly to be found at a depth of some hundreds of fathoms. Its having pelagic larvæ of the typical *Pluteus*-form seems also to agree with the fact that it does not live on the very great depths.

D. papillata has been taken by Ingolf on st. 1 (62° 30′ N. Lat., 8° 21′ W. L., 142 fathoms; bottom temperature 7° 8), 1 specimen, and st. 54 (63° 08′ N. Lat., 15° 40′ W. L., 691 fathoms; bottom temperature 4° 2), 1 specimen.

The statements that it has been taken in the Red Sea (Russo 348), at the Canaries, the West Indies, St. Paul, La Plata, and even at the Philippines, it will be best for the present to leave out of consideration, until a renewed examination of the material from these localities has been made. The statement that it is found at the Philippines, is made by Agassiz (Chall. Ech.); but he has himself expressed a doubt as to the correctness of the determination — and with good reason. I have in British Museum had occasion to examine the two specimens from the Philippines (Chall. sts. 204 and 210), and have found the one from st. 204 to be a *Cidaris* sp., and that from st. 210 a *Stereocidaris* sp. (I could not enter into a determination of the species.) The statement by Studer (386) that it has been taken at the Cape Verd Islands, must no doubt apply to *Cidaris affinis*; he remarks that the small spines were of a scarlet colour, which agrees with *C. affinis*, but not with *D. papillata*. I am also fortunate enough to be able to correct the statement by Russo that it is found in the Red Sea, as Prof. Monticelli has sent me the specimens for examination — they are *Cidaris baculosa*.

2. **Cidaris affinis** Phil.

Pl. I. Fig. 1. Pl. VI. Figs. 9—10. Pl. VIII. Fig. 2. Pl. IX, Figs. 1, 8—9, 11—12, 17—19, 21—24. Pl. XI. Figs. 1, 22.

Synonym: *Cidaris Stokesii* L. Ag. & Desor.

Dorocidaris neapolitana? Ramsay 331.

A. Philippi: Beschreibung einiger neuen Echinodermen nebst kritischen Bemerkungen über einige weniger bekannte Arten. Arch. f. Naturgesch. 1845. I. p. 351. — L. Agassiz & E. Desor: Catalogue raisonné des familles, des genres et des espèces de la Classe des Echinodermes. Ann. Sc. naturelles. 3 Sér. VI—VIII. 1846—47. — M. Sars: Middelhavets Littoral-Fauna. p. 110. — Wyv. Thomson: Echinoids of Porcupine (395). p. 726. Pl. LX.

Es ist mir unbegreiflich, dass man nicht schon längst die *C. affinis* von der *C. hystrix* unterschieden hat, da sie sich auf den ersten Blick durch dunkler rother Färbung und kürzere, spitzere und rauhere Stacheln auszeichnet — und bei Neapel gar nicht so sehr selten ist, says Philippi (op. cit. p. 352). It is still more inconceivable that later authors (Agassiz, Ludwig, Bell, a. o.) have reunited the two species. Wyv. Thomson himself is somewhat in doubt whether *C. affinis* is really specifically different from *Doroc. papillata*. By a thorough examination it is seen that they are not only two well separated species, but that they even belong to two different genera. *C. affinis* is to be referred to the genus *Cidaris* s. str., its nearest relations being *C. Reini* Döderl., *metularia* Lamk. *Thouarsii* Val. etc. — Although the northern boundary of this species is scarcely found so far north that it occurs in the territory the Echinid-fauna of which is treated in the present work, I nevertheless think it necessary to give a careful description of it, partly to prove my assertion that it has nothing to do with *Doroc. papillata*, but especially to prevent the two species being intermingled in future, as they have been so long, to the great injury of the study of the geographical distribution of these species. In the description those features are especially emphasized, in which it differs from *D. papillata*.

In the form of the test, the breadth of the ambulacral and the interambulacral areas, the number of ambulacral plates for each interambulacral plate (10—12), there is scarcely any difference of importance between this species and *D. papillata*. The interambulacral plates (Pl. VI. Fig. 10) are here

more closely covered with tubercles; there are ca. 15 on the edge of each areole, and outside of these there is a circle of tubercles opposite to the intervals of those of the first circle. Outside of these again several tubercles are found, more or less circularly arranged, so that the whole plate is covered, with the exception of a quite narrow stripe at the median line, — and on the lower part of the test it is also covered by the tubercles. No furrows in the edge of the plates. In the depth of the areoles there seems to be no distinct difference between the two forms.

The ambulacral area is more peculiar (Pl. VI. Fig. 9); the secondary tubercles lie here in the lower edge of the plate, so that they are situated opposite to the intervals between the primary ones (in *D. papillata* they, as described above, are placed in the middle of the ambulacral plates, opposite to the primary tubercles). The whole form of the ambulacral plates is consequently somewhat different from that of *D. papillata*. Only on the very uppermost and lowermost plates of the area the secondary tubercles are wanting; in the middle part of the area inside the secondary series some tubercles are found still a little smaller (the secondary tubercles are somewhat smaller than the primary ones), placed opposite to the intervals between the secondary tubercles, and consequently opposite to the primary ones, not, however, very regularly. — The pore area is a little more than half the breadth of the interjacent space, comparatively a little broader than in *D. papillata*, scarcely, however, of any great importance.

The spines 1—1½ time the diameter of the test (in *D. papillata* ca. 2—2½ times); they are evenly tapering, and end bluntly. About 18 longitudinal series of coarse serrations. Between these longitudinal series fine, slightly branched thorns are found, which do not coalesce and form a reticulation as in *D. papillata* (transverse section Pl. XI, Fig. 1). The radioles round the mouth are short, blunt, somewhat flat, without any dents in the edge, what they commonly have in *D. papillata*. As in this latter an «ampulla» is found at the base of the small spines, especially well developed at those of the apical area. There seems to be no difference of any importance in the form of the small spines of the two species.

The pedicellariæ are of the structure characteristic of the genus *Cidaris*. The large globiferous pedicellariæ (Pl. IX. Figs. 9, 22, 24): the mouth is situated quite at the top of the blade which is round and somewhat bent inward; it is surrounded by a limb that is a little bent outward and provided with rather large teeth the number and size of which is rather irregular. The upper end of the mouth has no limb nor any teeth; no end-tooth. The edge of the blade towards the point irregularly dentate. — At the transition between the broad and the narrow part of the stalk a limb is found of freely projecting, short calcareous ridges, prolongations of the rind-layer of the thick part of the stalk (Pl. IX. Fig. 12). This limb is most developed on the large globiferous pedicellariæ, but may also be rather distinct on the small pedicellariæ and the tridentate ones. The whole stalk is far more regularly constructed than in *D. papillata*: here the outer layer consists of smooth longitudinal ridges with small knob-like swellings, in *D. papillata* it is an extremely irregular, more or less spinous reticulation. — Size: the head ca. 0·7^{mm}, the stalk ca. 2^{mm}, but especially the latter is rather varying.

The small globiferous pedicellariæ are of a quite different structure (Pl. IX. Figs. 8, 11); they have a distinct end-tooth, and the mouth is large and situated a little below the point. The back-side of the blade is almost without the common holes in the line, only the basal part is perforated as

usual. — The tridentate pedicellariæ are a good deal smaller, but more long-stalked than in *D. papillata*; the head ca. 0·5mm, the stalk ca. 1mm or a little more (Pl. IX. Figs. 1, 18, 19, 21, 23). The blade is somewhat slenderer, and when the pedicellaria is shut there is a wide open space between the blades below; they join only in the point — scarcely the outer half of the blade — and this part of the blade is then obliquely cut off, while in *D. papillata* the whole edge of the blade forms a chiefly straight line. For the rest the construction of the blade is far more simple and less complicate than in *D. papillata*; the edge is finely indented, and only a few smooth beams cross the cavity of the blade.

It is a curious fact that tridentate pedicellariæ seem to be wanting in all the (6) specimens of *C. affinis* from the Mediterranean. On the other hand they are found in large numbers, not only in the ambulacral areas, but all over the test, in 5 specimens from 33° 20′ N. Lat. 77° 5′ W. L. 90 fathoms (near Florida), which our museum has received from U. S. Fish Commission (Smiths. Inst.) under the name of *Dorocidaris papillata, var.* In return the large globiferous pedicellariæ are extremely few in these specimens. Otherwise there seems to be no other difference of importance between these specimens and those from the Mediterranean. To be sure the spines (Pl. VIII, Fig. 2) are comparatively a little longer in the specimens from Florida, but as these are only half so large as the specimens from the Mediterranean, it may be taken to be a difference of age. To judge from the material in hand I must, at all events, regard them as being the same species, while I do not venture to decide, whether a distinction may be made between a Mediterranean variety and an Atlantic one.

The spicules of the tube-feet are arranged as in *D. papillata*. They are upon the whole a little more spinulous than in this latter, but the difference is extremely slight (Pl. XI. Fig. 22).

The diameter of the test of the largest specimen 38mm, the longest spine 54mm. The colour of this species, as has been observed by all the authors that have taken it to be a separate species, is lively red; the spines are brownish, with darker and lighter bands. The colour keeps rather well in spirit, sometimes excellently, as in the specimen figured on Pl. I. Fig. 1. — As color forms such an unimportant feature in the specific characters of Echini, much stress cannot be laid upon this point, says Agassiz. (Revision p. 255.) Here, no doubt, it is of some importance, as upon the whole the colour may be an excellent guide for distinguishing the species, for instance of *Echinus*.

Among the other *Cidaris*-species *C. Reini* Döderl. seems to be the nearest relation of *C. affinis*; they have both of them slender spines and a little limb on the stalk of the pedicellariæ. There seems to be no important difference in the form of the pedicellariæ in the genus *Cidaris*; it will scarcely be possible to distinguish the species with certainty by means of the pedicellariæ, but there seems also to be characters enough to be got from other features. The spines especially show a rather great richness in forms in this genus.

Accordingly *Cidaris affinis* will have to be added to the not few Echinids, found both in the Mediterranean and at the eastern coast of America. As to its distribution in other places only little can be said, as it has been intermingled with *D. papillata*. No doubt it will be found at the Atlantic coast of Southern Europe, and, as has been observed above, Studer's statement (386) of *D. papillata* being found at the Cape Verd Islands must surely apply to *C. affinis*. That it will also be found at the Azores, may be said with some certainty. It seems to be a more littoral form than *D. papillata*;

Sars has it from 50—100 fathoms; the specimens taken by Dr. H. I. Hansen at Syracuse are from 20—30 fathoms. The form mentioned from Florida is stated by Rathbun (336 p. 611) to be from 25—426 fathoms.

3. **Stereocidaris ingolfiana** n. sp.

Pl. VI. Figs. 1—5, 11. Pl. VIII. Figs. 4, 10, 11, 16, 19—21, 23, 26, 28, 30, 36. Pl. XI. Figs. 12, 16, 17, 23, 28, 30, 32, 33. Pl. XVI. Fig. 1.

Diameter	Height	Diam. of the peristome	Diam. of the apical area	Longest spines
35 mm.	27 mm.	14 mm.	15 mm.	
32 —	29 —	12 —	13 —	65 mm.
28 —	17 —	10·5 —	10·5 —	48 —
27 —	20 —	10 —	13 —	62 —
25 —	18 —	9 —	12·5 —	47 —
24 —	17·5 —	9 —	13 —	50 —
16 —	10 —	6·5 —	8 —	50 —
9 —	6·5 —	4 —	5 —	26 —

As will be seen from the given measures the height of the test is rather varying. Nevertheless the form is upon the whole very characteristic (Pl. VI. Fig. 3). It is broader above than below; the upper side is generally very flat, and there is, about the middle of the first fully developed interambulacral plate, a rather steep bending from the upper side to the almost perpendicular, below slightly inward bent sides. Below at the edge of the peristome a rather abrupt bending is likewise found; the two lowermost interambulacral plates are situated almost horizontally.

The interambulacral areas are $3^1/_2$—4 times as broad as the ambulacral areas; they consist of 5—7 plates. The areoles are deep, the edge round them raised, with a single circle of 15—16 more conspicuous tubercles; in large specimens these are more indistinct. The other part of the plates is closely set with very small tubercles, which are in the larger specimens rather distinctly arranged in irregular transverse rows; in smaller specimens this arrangement is not distinct. Even at the median line where the plates join, a narrow naked stripe is scarcely seen, in the largest specimen not at all. The plates sink somewhat down towards the median line and outward towards the pore area. Even the lowermost areoles are separated by a rather broad space with distinct tubercles (Pl. XVI. Fig. 1).

The ambulacral areas: There are 10—12 ambulacral plates for each interambulacral plate. The pore area is half so broad as the middle part of the ambulacral area. The pores are only separated by a narrow partition-wall; the outer pore is a little smaller. (In *D. papillata* and *C. affinis* the pores are of equal size; in the latter there is a rather broad partition-wall between them)[1]. The primary series of tubercles is only little conspicuous; besides the primary tubercle about 3—5 small tubercles are found on each ambulacral plate, so that there is no trace of naked intervals; the whole area between the series of pores therefore appears as a densely granulous stripe in which the boundaries between the separate plates are only seen with difficulty (Pl. VI. Fig. 11).

The plates of the peristome are set with numerous small tubercles, but only on the free edge. The apical area (Pl. VI. Fig. 4) is, as the other part of the test, closely set with small tubercles. The genital openings are rather large, the ocular plates are widely separated from the periproct, which is covered by smaller plates rather regularly arranged.

[1]) The figures (Pl. VI. Figs. 8, 9, 11) do not show this feature clearly.

In a quite young specimen, of a diameter of 7mm, with only 4—5 interambulacral plates, as yet almost no small tubercles (and spines) are found, excepting the primary series in the ambulacral areas, and the circle round the areoles (which are not yet deepened). Nevertheless no naked spots are seen on the test — there is no space for more tubercles. The apical area is closely set with small tubercles. There are as yet only 5 plates in the periproct, in the corners between the genital plates (which have not yet any genital opening). Round the anal opening there is a circle of small tubercles.

The spines are highly characteristic (Pl. VI. Figs. 1—2. Pl. VIII. Fig. 10). Most frequently they have a wing-shaped crest on the side turned upwards; sometimes 2—3 crests are found, sometimes none at all. Specimens are found, in which almost all the large spines are provided with wings, and other specimens, in which only a few spines or none at all have such crests. The more developed the crest is, the more compressed is the spine, to the very point. Where the crest is wanting, the spines are almost round and rather evenly tapering. There is a somewhat different number (10—16) of projecting longitudinal ridges with rather distinct thorns or dents. In young individuals (and spines) these ridges are more conspicuous, and they are here almost similarly developed, the thorns only a little more conspicuous in one of the ridges. Then the thorns of this ridge increase inordinately in size, and coalesce more and more from the base outward — and thus the crest is formed (Pl. XI. Figs. 17, 30, 32). Moreover the whole spine, the ridges (especially the crest), and the intervals are closely covered with delicate, obliquely situated hairs, the points of which are directed upward or outward (on the thorns). In dried specimens the spines are somewhat shaggy, and have a whitish tint from the air that is found between the hairs as in the hairy coat of a plant. In old spines this tint is not distinctly seen, but in young spines it may be very beautiful. In transverse sections of the spines (Pl. XI. Fig. 33) these hairs are seen to form a thick, complicated network on the outside of the outer layer of the spines. — The large spines are almost always turned directly to the side, so that the animal gets a peculiar flat appearance recalling a wheel (Pl. VI. Figs. 1—2). The spines round the mouth are flat, and have most frequently distinct, sharp dents in the edge.

The secondary spines are exceedingly numerous, and give the animal an almost shaggy appearance. Round the radioles a single circle of larger flat spines, of a length of $2^1/_2$—3mm, of the common form is found. In the primary series in the ambulacral areas the spines are somewhat narrower and only about half the length of those round the radioles, scarcely 2mm, the other small spines are still much smaller, ca. $^1/_2$—1mm. They are not distinctly compressed, and are not strongly pressed against the test, as is otherwise generally the case in the Cidarids. The spines round the radioles and those of the outer series of the ambulacral areas are often a little bent at the point and hollowed on the upper surface (Pl. VIII. Fig. 19), which is especially the case with the ambulacral spines nearest to the peristome. The spines of the peristome are generally somewhat widened at the point, and have, as it were, an indication of bisection, a thinner stripe being found downward from the middle of the point (Pl. VIII. Fig. 20). There is no »ampulla» at the base of the spines, at most a slight indication of such a one.

The pedicellariæ: The large globiferous pedicellariæ (Pl. VIII. Figs. 11, 16, 29) recall very much those of *D. papillata*, but by a closer examination they show no slight difference. There is no

unpaired tooth at the point. The mouth is large, broad below, more narrow above; it reaches to the very point. The edge is set with small teeth, the upper one on each side somewhat more distinct, sometimes much larger than the others (Pl. VIII. Fig. 26). These two uppermost teeth may be bent towards each other and coalesced towards the point, so that a little opening appears on the upper side of this apparently unpaired end-tooth, and when this is the case the resemblance to the pedicellariæ of *D. papillata* is considerable; but here, however, is never found the rather long, closed part below the end-tooth, which is found in *D. papillata*. The lower limit of the mouth generally forms a fine, regular curve. In a couple of specimens the point of the large globiferous pedicellariæ showed a deviating, but very irregular construction, which was much more like that in *D. papillata*. As these individuals otherwise agree exactly with the others, this deviation must be taken to be abnormal. It is a very conspicuous peculiarity in the large globiferous pedicellariæ of this species that the back-side is quite clear without holes all over the outer part of the blade; in *D. papillata* the back-side is highly perforated and of a very complicate construction to the very mouth. — Length of the head ca. 1^{mm}, the stalk often a little shorter. The structure of the stalk as in *D. papillata*.

The small globiferous pedicellariæ are upon the whole of the same construction as the large ones (Pl. VIII. Figs. 28, 30, 36); the uppermost pair of teeth may also here be coalesced at the points (Pl. VIII. Fig. 23). I have not been able to find tridentate pedicellariæ in any of the specimens in hand.

The spicules of the tube-feet (Pl. XI. Fig. 28) are very characteristic, and yield an excellent mark by which this species may be distinguished from the other Atlantic Cidarids. They are small fenestrated plates placed in two separated longitudinal series; they do not join on either side, such as is the case in *D. papillata* and *Cidaris affinis*. They are most developed on the tube feet below at the peristome, in the upper ones they are more simple and more like the common Cidarid-spicules. In quite small individuals they are often only much branched, not yet perforated plates. Upon the whole they are comparatively smaller than in *D. papillata*; they are slightly arched corresponding to the form of the foot, and are as usual situated transversely on the longitudinal axis of the foot.

In the intestine, the genital organs, and the organs of Stewart numerous spicules are found; those of the intestine have three rays, the others are larger, irregular plates (Pl. XI. Figs. 12, 16, 23). The dental apparatus shows no marked peculiarities. The auricles are rather high and narrow; on the ambulacral areas small and fine processes are found. (In *D. papillata* and *C. affinis* are likewise found rather well developed ambulacral processes. (Comp. Duncan 129). (Pl. VI. Figs. 5—6.)

In some of the specimens the lower part of the spines is slightly reddish; otherwise this species appears to have no marked colour. The preserved specimens are brownish.

Ingolf	St. 9.	(64° 18′	N. Lat.	27° 0′	W. L.	295	fathoms.	Bottom	temperature	6° 2).	16	specimens.
—	— 16.	(65° 28′	—	27° 05′	—	250	—	—		6° 4).	4	—
—	— 81.	(61° 44′	—	27° 11′	—	485	—	—		5° 7).	2	—
—	— 84.	(62° 58′	—	25° 24′	—	633		—		4° 4).	4	—
—	— 85.	(63° 22′	—	25° 21′	—	170	—	—		).	1	—
—	— 89.	(64° 45′	—	27° 20′	—	310	—	—		8°).	4	—
—	— 97.	(65° 28′	—	27° 39′	—	450	—	—		5° 1).	2	—

Further we have 5 specimens from the Denmark Strait (64° 42′ N. Lat., 27° 43′ W. L., 426 fathoms) obtained in 1889 by Wandel.

One more locality may be added for this species, viz. Albatross 1885, st. 2415, near Florida (30° 44′ N. Lat., 79° 26′ W. L., 440 fathoms) as, according to what has been mentioned above, a specimen received from U. S. National Museum under the name of *Porocidaris Sharreri* has proved to be identical with the species described here. I suppose that it has oftener been confounded with other Cidarids. At present, however, it is only known with certainty from the stations enumerated here: on the ridge south of Iceland, between Iceland and Greenland towards the ridge here separating the Atlantic from the Polar basin, and at Florida. The depth is 170—633 fathoms; accordingly it seems to be no genuine deep-sea form either.

Recent species of the genus *Stereocidaris* have first been described from Japan by Döderlein (Die japanischen Seeigel. 116); a species of the same genus, *St. indica* Döderl. (118) has later been taken by Valdivia in the Indian Ocean in many places and in many varieties, of which a couple, to judge from the preliminary description, seem to be so very like *St. ingolfiana*, that it will be difficult to distinguish between them; but Prof. Döderlein, to whom I have sent a specimen of *St. ingolfiana* for examination, has informed me that he thinks the two species to be good ones. With the species described here the occurrence of the genus also in the Atlantic is proved; this genus thus appears to be cosmopolitan.

4. **Porocidaris purpurata** Wyv. Thomson.

Pl. VI. Fig. 12. Pl. VIII. Fig. 22. Pl. X. Figs. 1—2, 5. Pl. XI. Figs. 3, 21.

Synonym: *Porocidaris gracilis* Sladen.

Wyv. Thomson: Echinoidea of Porcupine (395) p. 728. Pl. LIX. & LXI. 14—15. — Bell: Catalogue (73) p. 141. — Hoyle: 202. p. 405. — Sladen: 367.

With regard to this easily distinguished species I have only little to add to the excellent description by Wyv. Thomson.

The ambulacral areas: Inside the outer, primary series of tubercles a somewhat smaller tubercle is found in the lower corner of each plate, and moreover a quite small tubercle below the primary one, which accordingly does not fill up the whole breadth of the plate. There is, however, some irregularity; one or the other of the small tubercles are not rarely wanting, sometimes both of them. Also the pores are different from those of the other Cidarids mentioned here, as will be seen by a comparison of the figures (Pl. VI. Figs. 8—9, 11—12).

The spicules are arranged in the tube feet as in *D. papillata*; the two series, however, do not always join closely, naked spaces are often seen between them, in which only a few spicules are joining. They are somewhat complicated, the thorns on the outer side coalescing and forming a more or less distinct net of meshes (Pl. XI. Fig. 21).

Of the very characteristic two-valved pedicellariæ Wyv. Thomson (op. cit. p. 729) says: "Their structure is in every way the same as that of the ordinary three-valved pedicellariæ, except in the number of the valves. All the usual chambers and ridges are developed, and the different muscles are very evident through the transparent walls". In this statement I do not agree with Wyv. Thomson. These pedicellariæ are highly different in structure from common tridentate pedicellariæ, with which they must most nearly be compared (Pl. X. Fig. 1, 2, 5). They have no apophysis; the whole

basal part is an undivided cavity in accordance with the fact that muscles are only running in one direction between the two valves. (In the common three-valved pedicellariæ muscles, as is well known, run in two diverging directions from each valve, and the apophysis may be taken to serve chiefly for the attaching of these muscles). The structure of the stalk is as in *D. papillata*. Other kinds of pedicellariæ do not appear to be found in this species (genus).

The spines have no hair-covering on the outer layer, as was the case in the three preceding species; but the outer layer itself is beautifully and regularly striped longitudinally, and is in transverse sections seen to be divided into areas, one area for each raised ridge. The more conspicuous ridges are formed by two parts of equal height, joined almost to the point (Pl. XI. Fig. 3).

«Ingolf», st. 73 (62° 58′ N. Lat. 23° 28′ W. L. 486 fathoms. Bottom temperature 5° 1). 3 specimens.

Hitherto the species was only known from the Faröe Channel, from 530—542 fathoms.

The smallest of the specimens in hand (diam. 10^{mm}, height 7^{mm}, longest spine 27^{mm}) agrees exactly with the description of *Porocidaris gracilis* Sladen (op. cit.). The form is the same; the radioles are not separated, only one tubercle on each ambulacral plate, no openings in the genital plates — as in *P. gracilis*; only the colour is more light (bleached) than in Sladen's specimen. There can be no doubt, however, that it is a young *P. purpurata*, and *P. gracilis* Sladen must then, as supposed by Bell (op. cit. p. 142) be taken to be synonymous with *P. purpurata*.

It is especially by the spines that the young *P. purpurata* differs from the grown one. In Sladen's specimen they were «finely striated longitudinally, the ridges being very slightly prominent and marked with very faint and indistinct serrations». In the specimen in hand, which is a smaller one, the spines are very different between themselves, some are provided with rather highly serrate longitudinal ribs, others are densely covered with coarse thorns, without any trace of longitudinal ribs; a couple are only faintly serrated, and a single one of the uppermost ones is completely smooth, quite as in the grown *P. purpurata*. Also in the grown one the lower radioles are rather distinctly serrated, while the upper ones, with the exception of a few coarse thorns, only are finely striated longitudinally. The radioles round the mouth are serrated as in the grown one, only, however, with 1—2 teeth on either side.

Sladen's specimen was taken S. W. of Ireland on 51° 1′ N. Lat., 11° 50′ W. L., 750 fathoms.

Table of the Cidarids occurring in the northern Atlantic and the Mediterranean.

1.	Pedicellariæ 2-valved; the spines with highly developed neck	*Porocidaris purpurata* W. Th.
	— 3-valved; the spines with short neck	2.
2.	The globiferous pedicellariæ, as well the large as the small ones, with an unpaired tooth at the point of the blade; the mouth does not reach to the point of the blade, and is most frequently irregularly limited below. The spicules formed as spinous arcs.....	*Dorocidaris papillata* (Leske).
	The large globiferous pedicellariæ withouth end-tooth; the mouth reaches to the point of the blade, and is regularly limited below. (Sometimes an unpaired end-tooth may apparently be	

found on the large pedicellariæ; when this is the case, the spicules (fenestrated plates) will show that it is no *Dorocidaris*) ..... 3.

3. The large globiferous pedicellariæ with large mouth; the blade not prolonged. The stalk has no limb of projecting calcareous ridges. The small pedicellariæ without end-tooth. The spicules fenestrated plates ..... *Stereocidaris ingolfiana* Mrtsn.

The large globiferous pedicellariæ with a little mouth at the end of the somewhat prolonged blade. The stalk with a limb of projecting calcareous ridges. The small globiferous pedicellariæ with end-tooth. The spicules spinous arcs ..... *Cidaris affinis* Phil.

Fam. Echinothuridæ.

The classification of the Echinothurids is distinguished by a pleasing simplicity; only three recent genera are known, *Phormosoma*, *Asthenosoma* and *Sperosoma*, and, what is still more pleasing, there are only two synonyms of these names, viz. *Calveria* W. Th., and *Cyanosoma* Sarasin. To the genus *Phormosoma* 10 species have been referred, to *Asthenosoma* 11, and to *Sperosoma* 2 species, most of which species have been described by A. Agassiz, the rest by Wyv. Thomson, Koehler, Döderlein, and Yoshiwara, all during the last three decades. Here, then, we seem to have a division of Echinids where the classification is in the best possible order. — The joy, unfortunately! does not last longer than until the moment when one has to determine Echinothurids oneself. Then one will soon reecho the complaint of Sarasin: Wir wissen nicht, warum es A. Agassiz seinen Lesern so sehr sauer gemacht hat sich in seinen Challenger Echiniden zurecht zu finden. Um einen Echinothuriden daraus zu bestimmen ist es nötig die bei den einzelnen Arten gemachten Angaben sorgfältig zu analysieren, unter Rubriken zu ordnen und dann die Bestimmung zu versuchen (352. p. 96). We might, however, let that pass, if all the difficulties were to be superseded in this way; but this, unfortunately, is not the case, as it will soon appear that the two large genera, *Phormosoma* and *Asthenosoma*, are in reality not to be distinguished from each other with certainty.

The chief difference between these genera is stated to be the fact that in *Phormosoma* the plates overlap each other in the whole length of the edge, while in *Asthenosoma* the plates are narrower in the middle, so that naked interspaces are left only covered by the skin; only the broader ends of the plates overlap each other in the way peculiar for the Echinothurids. Now there is, however, the drawback by this statement that the arrangement of the plates is generally only to be seen in dried specimens. But the Echinothurids are only very little adapted for preservation in dried state, and if the material in hand be slight, one does not like to destroy it for the sake of determination. And even if the material is copious enough, so that it is possible to examine the plates exactly, we are by no means sure to arrive at a result. Bell (72) has shown that there is a considerable variation as to the size of the uncalcified membranous space between the plates: this may be quite conspicuous or calcification may have gone so far, that it is difficult to detect the membranous interspace. —

From the specimens before me I am compelled to conclude, that the amount of calcification of the plates is a point in which individuals living together may differ among themselves.

As another important difference between the two genera Wyv. Thomson (395) emphasizes the fact that in *Phormosoma* the actinal side is very different from the abactinal side, while in *Calveria* (which is, according to Agassiz, synonymous with *Asthenosoma*) both sides are rather equal. This character was excellent, as long as only the species described by Wyv. Thomson were known; but it could not hold good with regard to the large number of new species brought to light by the «Challenger»-Expedition. Agassiz has also several times declared, although only in an indirect way, that the two genera cannot in reality be kept distinct. In the «Challenger» Echinids (p. 87) he says of young specimens of *Asthenosoma pellucidum* that they show «how close is the relationship between the genera *Phormosoma* and *Asthenosoma* in spite of the apparently great structural differences existing between the adult of such species as *Asthenosoma Grubei* and *Phormosoma luculentum*. It is mainly from the comparatively larger number of coronal plates in the former genus, that the young of the two genera can be satisfactorily distinguished, the other characteristic features, the lapping of the plates appearing only in larger specimens». Of *Phormosoma panamense* Agassiz says (13. p. 77) that it has «on the actinal side the characters of *Phormosoma* most decidedly developed, while on the abactinal side the great elongation of the ambulacral plates and the arrangement of the coronal plates resemble the structural features of *Asthenosoma*».

Thus we have no fully reliable characters for the two mentioned genera. We have then to choose between two alternatives: to make the whole one genus, or to search for better characters. The first alternative is only a confession of incompetency; we must try the second. — It is beforehand probable that good characters must be found, as these animals show so rich a variety of interesting structures. The examinations have also in ample measure borne out the anticipations of finding good characters. The arrangement of the tube feet, the structure of the spines, the spicules, and above all the pedicellariæ, yield most excellent characters, as well with regard to genera as to species. The old genera Phormosoma and Asthenosoma prove to be highly heterogeneous; several new genera will have to be established.

Besides the rich material of the «Ingolf»-Expedition, and what was previously found in our museum, I have examined the type specimens of all the new species from «Challenger» described by Agassiz, to which species Prof. Bell most liberally granted me admission during my stay at British Museum. Further Prof. Pfeffer has kindly sent me a couple of specimens of *Asthenosoma varium* Grube for examination. Accordingly my examinations rest on a very broad base; with the exception of *Phormosoma hispidum*, *panamense*, *Asthenosoma longispinum*, *Iijamai*, and *Sperosoma biseriatum*, I have examined all known species, and of almost all of them the type specimens.

As already mentioned, it is the spines, the pedicellariæ, the tube feet, and the spicules, which bear the principal part in the new classification of the Echinothurids that is the result of these researches. Of course also the structure of the test is always of importance; but the all-predominant importance that has hitherto been attached to the form and mutual relation of the plates, will have to be very much reduced. In most Echinothurids the primary spines on the actinal side are provided with a peculiar, hoof-shaped terminal cap, of a structure different from that of the other part of the

spine; it is very large and conspicuous in some species, as *Ph. hoplacantha*, *Sperosoma Grimaldii* a. o., small in *Asthenosoma Grubei*, *hystrix* a. o. These spines are always (?) more or less curved. — In a group of species: *Phormosoma placenta*, *bursarium*, and *rigidum* (a. o.?) the primary spines of the actinal side are surrounded by a bag of skin, and their points are swollen in a club-shaped way. In *Asthenosoma Grubei*, *varium*, *heteractis*, and *urens* the spines on the abactinal side, primary and secondary ones, are inclosed by a thick cutaneous sheath which is constricted one or several times; also in other Echinothurids, for instance *A. hystrix*, small bags of skin are seen at the point of the small spines. These spines are distinctly distinguished from the mentioned skin-covered spines in *Ph. placenta*, *bursarium*, and *rigidum* by being constructed as usual — simple perforated tubes with a long, fine point, while in *Ph. placenta* etc. they are swollen at the point, and filled by an irregular calcareous net of meshes.

The tube feet may be arranged in an almost straight line on the actinal side, as in *Ph. placenta*, or they may be trigeminous, about as in an *Echinus*, as for instance in *A. hystrix*, or they may be arranged in three widely separated series, as in *Sperosoma*. In some there is no trace of a sucking disk on the tube feet of the actinal side, in others there is a well-developed disk; on the abactinal side a sucking disk is never found. The spicules are almost always rather large, irregular, fenestrated plates situated more or less distinctly in 3—4 longitudinal series. In *A. varium*, *Grubei*, *heteractis*, and *urens* they are very slightly developed, only small, branched calcareous pieces, rarely with a hole. — The sphæridiæ, which follow the tube feet quite up on the abactinal side, show no differences so great that they can be of any systematic importance. The pedicellariæ, on the other hand, are of the greatest importance with regard to the classification.

No less than 5 different kinds of pedicellariæ are found in the Echinothurids, viz. the four kinds known from the Echinids, and further the very beautiful form, described by Wyv. Thomson in *A. fenestratum*, the tetradactylous pedicellariæ. Only the tridentate and the triphyllous pedicellariæ are found in all Echinothurids, each of the other kinds are only found in a single genus. — The tetradactylous pedicellariæ have been so excellently described and figured by Wyv. Thomson, that I need not add anything. Globiferous pedicellariæ were hitherto unknown in the Echinothurids; I have found them in *A. pellucidum* (in one of the type specimens from Chall. st. 192; the other specimens I have not seen). They are highly primitive; the skeleton consists of three simple rods, a little widened below. No muscles seem to pass between them, which corresponds very well with the fact that the three glandular bags are quite inclosed by a common skin; the pedicellaria cannot be opened as other pedicellariæ. The valves have only half the length of the head, and they are placed between the glandular bags (Pl. XIII. Fig. 24). There can scarcely be any doubt that this interesting form of pedicellariæ is to be interpreted as a very primitive globiferous pedicellaria.

Neither were ophicephalous pedicellariæ hitherto known in the Echinothurids. The form of pedicellariæ figured and described by Wyv. Thomson as ophicephalous pedicellariæ, is indisputably the triphyllous pedicellariæ, very similar to the triphyllous pedicellariæ of the Echinids, only somewhat larger. Genuine ophicephalous pedicellariæ I have only found in the new form *Tromikosoma Kochleri*, described here. They are very characteristic, the blade is highly constricted just above the basal part, and abruptly widened above (Pl. XIV. Figs. 19, 23, 25). The somewhat contorted arc on the lower side of each valve, so characteristic of the ophicephalous pedicellariæ, is here typically developed,

so that there can be no doubt that it is a genuine ophicephalous pedicellaria. It is a highly curious fact that each of these three kinds of pedicellariæ, two of which show a very perfect development, are only found in a single genus, while none of the other Echinothurids seem to have a corresponding form of pedicellariæ.

The tridentate pedicellariæ are very richly developed in the Echinothurids. Most frequently their form is simple; the valves are leaf-shaped, and the blade is more or less filled by a net of meshes which may be very spinous. In another common form the edges of the blade are involuted, so that only the point of the blade is somewhat widened; in this form the blade is commonly strongly bent, so that the valves are widely separated, and only join with their points when the pedicellaria is closed. Both these forms may be found in the same species; and in a group of species, *A. varium* and the species most nearly allied to it, even three different kinds of tridentate pedicellariæ are found, viz. besides the two mentioned forms a short, broad one with coarsely serrate edge (Pl. VIII, Figs. 4, 27). A peculiar short and broad form is found in *Ph. luculentum*; it recalls to some degree an ophicephalous pedicellaria, but as it has no indication of an arc, there can scarcely be any question of interpreting it as any thing else than a form of the tridentate pedicellariæ. The tridentate pedicellariæ may be very large, especially those with involuted edge; these have commonly a very short neck.

The triphyllous pedicellariæ (Pl. XII, Pl. XIII. Fig. 23) are very well developed in the Echinothurids; peculiar to these in comparison with the triphyllous pedicellariæ of the Echinids is the fact that the upper edge of the apophysis spreads over the lower part of the blade, and continues up along its sides; in some, for instance *Ph. placenta*, this «cover-plate» is not much developed, in most species it is highly developed, and covers a great part of the blade. Generally there are then some large holes in the median line, and some smaller holes around; the part continuing upward along the lateral edges of the blade, is most frequently without holes. The upper edge of the blade is generally finely serrate. The holes in the blade are always placed in rather regular curves from the middle obliquely upward on either side. — The peculiar bottle-shaped, two-valved pedicellaria, figured by Agassiz from *Phormosoma tenue* (Chall. Echinoidea. Pl. XLIV. Fig. 21) is presumably an abnormal form. I have examined a couple of the type specimens, but have only found the common, three-valved form. Agassiz (Chall. Echinoidea. p. 84) thinks that «this bottleshaped pedicellaria is only a modification of the ordinary type of pedicellariæ, in which the terminal edge becomes raised to form a spoon-shaped valve». This is absolutely wrong; one form is a triphyllous pedicellaria, the other a tridentate one.

The stalk of the pedicellariæ in by far the greatest number of Echinothurids is thin, irregularly perforated, not distinctly tube-shaped (Pl. XIV. Fig. 31). In the large tridentate pedicellariæ, as in *A. varium*, also the stalk is somewhat coarser; the stalk of the ophicephalous pedicellariæ of *Tromikosoma* is a rather thick tube. In *Ph. asterias* the construction of the stalk is quite exceptional among the Echinothurids; it consists of some long, very thin calcareous threads, only united at the ends of the stalk, at most connected in the intervening part by quite few transverse ridges.

Also the inner anatomical structure seems to yield good systematic characters. Thus Bell (Catalogue p. 142) mentions as a chief difference between the genera *Phormosoma* and *Asthenosoma* that the latter has highly developed «longitudinal muscles» dividing the body-cavity into chambers, while such muscles are wanting in *Phormosoma*. — To this, however, is to be remarked that the specimens

of *Phormosoma placenta* I have opened, had typically developed, but, to be sure, very fine and fragile longitudinal muscles. Bell (69) has likewise shown that the organs of Stewart are rudimentary or wanting in *Ph. placenta*, *bursarium*, and *tenue*, while in other forms they are highly developed, as has been shown by Sarasin (352) with regard to *A. urens*, and by Koehler with regard to *Ph. uranus*» (229).

If we now look over the Echinothurids with regard to the structures mentioned here, we shall see that the old genera *Phormosoma* and *Asthenosoma* cannot be kept up to the extent in which they have hitherto been taken; several new genera will have to be established. The species will have to be grouped in the following way:

Phormosoma placenta. The primary spines on the actinal side are club-shaped, inclosed by a thick bag of skin. The tube feet on the actinal side arranged in a single series; no sucking disk developed. Tridentate pedicellariæ simple, with leaf-shaped, rather deep valves having only a slightly developed net of meshes at the bottom. The spreadings from the upper end of the apophysis do not reach to the lateral edges of the blade. Very nearly allied to this species is *Ph. bursarium* A. Ag. The spines on the actinal side are as in *Ph. placenta*; on the abactinal side the spines are curved, by which feature it is distinguished from the latter species. The pedicellariæ are as in *Ph. placenta*; the tridentate pedicellariæ occur (in the same individual) in a long, narrow form (Pl. XII, Fig. 1), and a short, broad form, as it will be described below in *Ph. placenta* (Pl. XII. Figs. 2, 3); (in this species both forms do not appear to be found in the same individuals). The narrow ones have often some rather large, inward directed teeth a little inside of the edge on the lower part of the blade. In the triphyllous pedicellariæ (Pl. XII, Fig. 28) the cover-plate is a little more developed than is the case in the form typical for *Ph. placenta*; but in this species similar triphyllous pedicellariæ may also be found together with the typical form. The spicules form two longitudinal series placed just above either edge of the partition-wall in the tube foot; from the middle of the lower side of the spicules a continuation passes into the partition-wall, by which means a dark line appears along the middle of each series of spicules. Such continuations from the spicules into the partition-wall are not seen in *Ph. placenta*, and seem upon the whole not to be found in other of the Echinothurids examined here. Besides the two longitudinal series more or fewer scattered spicules are found, sometimes so many, that the chief series become indistinct. The spicules are the common irregular fenestrated plates, perhaps a little larger than in *Ph. placenta.* No sucking disk is found.

Agassiz (Chall. Ech. p. 99 seq.) is not quite sure whether this species is not possibly identical with *Phormosoma luculentum*; more abundant material may prove, that the differences noticed, although important, are simply individual characteristics partly due to age . He takes much care to show, in which features the two species are distinguished — a rather superfluous work! The two species are very different, which may be seen directly by a glance at the figures given by Agassiz, and, as will be shown here, they cannot even be referred to the same genus. On the other hand Agassiz unfortunately has not observed that *Ph. bursarium* is very similar to *placenta*; it would have been of considerably higher importance, if we had been informed of the characters by which it is distinguished from this latter. To be sure Agassiz (Chall. Ech. p. 100) observes that it is distinguished from *Ph. placenta* «in the greater height of its coronal plates and the presence of large primary tubercles

extending both in the ambulacral and interambulacral areas far towards the abactinal system». This, however, seems to be no conspicuous difference; on the other hand the curved spines on the abactinal side and the peculiar feature with regard to the spicules may perhaps be taken to be good characters of this species.

One more species must be classed with the two mentioned ones, viz. *Phormosoma rigidum* A. Agass. It resembles very much *Ph. placenta*. The primary spines on the actinal side are covered with skin, what I have been able to substantiate on the type specimen[1]). The pedicellariæ as in *Ph. placenta*; only a narrow form of tridentate pedicellariæ has been found (Pl. XII. Fig. 6). The spicules are placed in three rather distinct longitudinal series; they are a little lengthened, and are almost parallel to the longitudinal axis of the foot. No sucking disk. — It seems to be rather difficult after the only specimen in hand to give any sure character for the distinguishing between this species and *Ph. placenta*, nor do we get any guidance from the description by Agassiz; to be sure he has observed that the actinal side reminds very much of *Ph. placenta*, but otherwise he does not seem to regard them as more nearly allied. In reality it is not improbable that they may be the same species. *Ph. rigidum*, it is true, has only been taken at New-Zealand, and *Ph. placenta* only in the northern part of the Atlantic, — but if *Ophiomusium Lymani* can be found as well in the Atlantic as in the Pacific (which is a sure fact), the same may also be the case with *Ph. placenta*. New material, however, will be necessary for the decision of the question.

The three mentioned species form a separate group, sharply distinguished from all other Echinothurids, as far as known, above all by their peculiar, skin-covered spines on the actinal side. Agassiz, to be sure, thinks that this feature has no special systematic importance. The presence of sheated spines in two species of *Phormosoma* shows that this character, which at first sight seems to separate so strikingly from the rest of the species of the group *Asthenosoma grubei*, is evidently one of little value, and which may be more or less developed in specimens of the same species in the same state of growth (Chall. Ech. p. 101). — As already mentioned above, the facts here put together by Agassiz are quite different: in *A. grubei* it is the spines on the abactinal side that are wrapped by a bag of skin, and the spine itself is of the common structure, a perforated tube ending in a fine point; in *Ph. placenta* and the species allied to it, it is the primary spines on the actinal side that are clavately widened in the point and wrapped by a thick bag of skin. These spines must, of course, be compared with the primary spines on the actinal side of the other species; but then we find a marked contrast, these spines of the other species not being covered with skin — as far as is known — but ending in a larger or smaller hoof, distinctly marked off from the spine itself. There can be no doubt that the three mentioned species form a separate genus, to which, of course, the name of *Phormosoma* is due. The other species referred to *Phormosoma* must be referred somewhere else. Possibly, however, *Ph. panamense* is also a genuine *Phormosoma*; Agassiz (13) says that its actinal side has «the characters of *Phormosoma* most decidedly developed»; otherwise he takes it to be nearly related to *Ph. tenue*, but thinks that perhaps it may prove to belong to a new genus intermediate between *Phormosoma* and *Asthenosoma*. The description gives otherwise only very incomplete informations of this species, and no figures are given.

[1]) As this specimen is said by Bell (69) to have disappeared, I must observe that it has later been found again.

Another very distinctly marked group is formed by the species *Asthenosoma varium* Grube, *Grubei* Agass., *urens* Sarasin, and *heteractis* Bedford, all which species I have had occasion to examine. The primary spines on the actinal side are curved, and end with a thin, but rather long, little conspicuous hoof; they are green with dark rings. All the spines on the abactinal side and the secondary ones on the actinal side are covered with skin; on the larger spines the bag of skin is repeatedly constricted (Chall. Ech. Pl. XVI), on the small spines there is only a simple bag of skin at the point (poison apparatus — Sarasin 350, 352); these skin-covered spines end in the usual point. The tube feet are placed in three dense series; in the actinal tube feet a well developed sucking disk is found. The spicules are small, irregularly branched, rarely with a single hole (Pl. XI. Fig. 20); only just below the sucking disk a few larger fenestrated plates are found. They are placed in 2—4 series, but only in the outer part of the foot, nearest to the sucking disk; in the other, larger part of the tube foot only quite few scattered spicules are found, and also in the abactinal tube feet only very few spicules are found. This feature of the spicules also separates this group of species very distinctly from all the other Echinothurids.

The pedicellariæ of these species are especially characteristic (while on the other hand there is only very little difference in this respect between the species themselves). Only tridentate and triphyllous pedicellariæ are found here, but in return the tridentate ones are found in no less than three well marked forms. In the largest form the blade is narrow, only widened in the point and provided with 2—3 very coarse indentations which work into each other when the pedicellaria is shut; below the blades are then widely separated; there are no fine teeth in the edge of the blade (Pl. XIV. Figs. 3, 7). Now, to be sure, I have only seen this form in *A. varium* and *Grubei*, but I think there is no doubt that it is also found in the two others. There appears, besides, some difference between *A. varium* and *Grubei* just with regard to this form of pedicellariæ, they being much slenderer in *A. varium* than in the other; in both they have a length of 2—2·2^{mm} (the head). The neck is quite short. — This difference in the pedicellariæ of the two species indicates that *A. Grubei* is really a good species, and not synonymous with *A. varium*, as Agassiz is inclined to think (Chall. Ech. p. 84).

The second, smaller form of tridentate pedicellariæ (Pl. XIII. Figs. 4, 27) reminds very much of ophicephalous pedicellariæ; but as no indication of arcs is found here, there can be no question of referring them to this kind; they are a highly modified form of tridentate pedicellariæ. The blade is short and broad, filled by a rich net of meshes, and with 2—3 large indentations in the edge, which is otherwise smooth as in the large form. When the pedicellaria is shut the blades join with the exception of a quite small space at the base. Also this form has a very short neck. The length of the head 1·2—1·5^{mm}. This form as well as the following one and the triphyllous pedicellariæ are quite identical in all four species. — On Pl. XVI. Figs. 10 and 11 in the Challenger-Echinids Agassiz gives tolerably recognizable figures of this and the following form of pedicellariæ; — «large, short-stemmed» and «small-headed, long-stemmed pedicellariæ» they are called. Pl. XLIV. Fig. 34 likewise gives a rather good figure of a valve of the second tridentate form, and Fig. 36 of the third form, which is here called «large-headed». But it would be difficult to say what is meant by Pl. XLII. Fig. 9, and Pl. XLIII. Fig. 2, although the former is given as a «long-headed, long-stemmed», the latter as a «long-stemmed, small-headed» pedicellaria of *A. Grubei*. On the other hand the pedicellaria

figured on Pl. XLII. Fig. 8, which in the explanation of the figures is called a globular-headed, short-stemmed pedicellaria of *A. Grubei*, is easily recognizable; but does it really belong to *A. Grubei*? I have not been able to find such pedicellariæ, neither in *A. Grubei* nor in the other allied species. But it is strikingly similar to the peculiar short-headed pedicellaria of *Ph. luculentum* figured by Agassiz (Pl. X. a. Fig. 7, and Pl. XLIV. Figs. 25—26), and I must suppose a confounding to have taken place.

The third, smallest form of tridentate pedicellariæ (Pl. XIV. Fig. 10) is more simple, but also highly characteristic. The blade is simple, but the apophysis continues into it as a high, sharp, coarsely serrate keel; in the larger specimens of this form the keel reaches to the very point of the blade, in the smaller generally only to the middle of the blade. On the sides of the keel there is a rather coarse net of meshes which is, however, far from filling the blade; in the small specimens this net of meshes is only slightly developed. The edge of the blade is finely serrate. When the pedicellaria is shut, the edges join through the whole length, only a quite small opening is found below. This form has a rather long neck. The head 0·5—1^{mm}. — In the triphyllous pedicellariæ the coverplate is well developed, with a few holes; the edge of the blade is beautifully rounded and finely serrate (Pl. XII. Fig. 18). The stalks of the pedicellariæ are of the common structure, only somewhat stronger than is else the case in the Echinothurids.

This group of species is very sharply distinguished from all the other Echinothurids, and must form a separate genus, which will, of course, get the old name of *Asthenosoma*. The other species referred to *Asthenosoma* do not justly belong to this genus, no more than the other species referred to *Phormosoma* do in reality belong there.

As mentioned above, Agassiz is inclined to think that *A. Grubei* is identical with *A. varium*. Also de Loriol (246) advocates the same opinion. «La réunion de ces deux espèces me paraît fort probable; cependant les exemplaires d'Amboine paraissent différer de ceux que M. Agassiz a fait figurer, par leur forme circulaire, un arrangement des plaques un peu différent dans les zones porifères et, aussi, par la structure de l'appareil apical qui, d'après le dessin ne serait pas la même (p. 367). To this may be added the difference of the large pedicellariæ pointed out above. — As I have not had both species for examination at the same time, and have moreover only seen a large specimen of *A. Grubei* and a couple of small ones of *A. varium*, I shall give no decided opinion of this question.

In the work quoted above de Loriol further describes a young Echinid which he calls *Asthenosoma varium??* — Il me paraît extrêmement probable que le petit exemplaire..., qui est un jeune d'une espèce de la famille des Echinothurides, peut être envisagé comme celui d' *l'Asthenosoma varium* Grube. It is scarcely an Echinothurid at all, far less a young one of *A. varium*. As appears from the description and the figures, the arrangement of the pores (a single, regular series), the spines, the buccal membrane, the apical area are all so different from what is else characteristic of the Echinothurids, that there can certainly be no question of its being referred there. For the present I shall express no conjecture as to where it may really have to be referred.

Ludwig (257) is inclined to think that one of the specimens examined by him is a different species from *A. varium*, especially because its large pedicellariæ are different from those of *A. varium*. The figure given shows, however, that it is only the second, broad form of tridentate pedicellariæ that

Ludwig has found in this specimen, while he has not seen this form in the other specimens. I shall express no opinion whether it be otherwise the same species or not.

Asthenosoma hystrix. The tube feet are placed in three dense series; a well developed sucking disk is found in the actinal tube feet. In the upper part of the tube foot the spicules are large, irregular fenestrated plates quite inclosing the foot; in the lower part of the foot they are placed in two distinctly separated series, and are more or less rod-shaped, with few holes (Pl. XI. Fig. 29). The primary spines on the actinal side end in a little hoof. Only tridentate and triphyllous pedicellariæ are found. Of tridentate pedicellariæ two forms are found, not very sharply distinguished. In the larger form (Pl. XIV. Fig. 26) the edges of the blade are involuted, only the point is a little widened, with a remarkably irregular, finely serrate edge. In the smaller form (Pl. XIII. Figs. 17–18) the involuted part of the blade is shorter, the widened part comparatively larger and less irregular in the edge; when the pedicellaria is shut, the valves are far less separated below than in the larger form (see Wyv. Thomson: „Porcupine"-Ech. Pl. LXIV. Fig. 5). This form occurs in very varying sizes. In the triphyllous pedicellariæ the cover-plate is highly developed, with a few, large holes along the median line; the edge finely serrate (Pl. XII. Fig. 34). The stalk of the pedicellariæ of the common structure.

It is evident that this species is not nearly allied to *Asthenosoma*, as here limited. Accordingly it must form a separate genus keeping the name of *Calveria*, which was originally given to it by Wyv. Thomson, and which it has unjustly been deprived of. To the same genus „*Asthenosoma gracile* A. Agass. will further have to be referred. Its pedicellariæ (Pl. XIII. Fig. 3) agree so exactly with those of *C. hystrix*, that no distinct specific difference seems to be found in this feature; only the smaller form of tridentate pedicellariæ is a little slenderer than in *C. hystrix*. The primary spines end in a small hoof as in *C. hystrix*; the tube feet are arranged in the same way as in this latter. The spicules are rather large, irregular fenestrated plates; in the lower part of the tube foot they are smaller and arranged in two well separated series, in the upper part they join completely, and form a close mail round the foot, as figured by Wyv. Thomson from *C. hystrix* („Porcupine"-Ech. Pl. LXIV. Fig. 3). The sucking disk well developed. — Agassiz, who has seen, to be sure, that this species is very similar to *C. hystrix*, mentions in his description of it (Chall. Ech. p. 98) some peculiarities with regard to the arrangement of the tubercles as „special characters"; in pedicellariæ and tube feet no distinct specific difference seems to be found, so that for the present we must rest satisfied with the statements of Agassiz.

I discovered a very interesting feature by the examination of the type specimen of this species. Some of the secondary spines were swollen at the point (Pl. XIV. Fig. 27), and in the swollen part proved to be sitting a little parasitic Copepod. This seems to be a case of parasitism hitherto quite unknown, and in interest scarcely below that found by Koehler: the gall-forming, parasitic Copepoda in „*Phormosoma uranus* (229)[1]).

The characters here mentioned for *Calveria gracilis* as well as the mentioned feature of the parasitic Copepod, apply only to the specimen from Chall. st. 200. — Of some specimens from sts. 184 and 219 Agassiz says that he refers them to this species „with considerable doubt", in which he is

[1]) The parasite will be described by Dr. H. I. Hansen in Vidensk. Medd. fra Nat. Foren. Kobenhavn.

quite right. They belong to two different species, most likely also to different genera, and none of them has any relation to *C. gracilis*.

The specimen from st. 219 has a remarkable form of tridentate pedicellariæ; the blade is long, narrow, with uneven, finely serrate edge, deep and in the lower part filled by a net of meshes. The valve figured on Pl. XIV. Fig. 20 is from one of the smaller pedicellariæ. I have only found this form of tridentate pedicellariæ. The triphyllous pedicellariæ (Pl. XII. Fig. 13) have a well developed cover-plate with few holes; the edge finely serrate. The stalk of the pedicellariæ of the common structure. The spicules are large fenestrated plates arranged in two well separated series; the sucking disk well developed. The tube feet are arranged in three series. None of the primary spines on the actinal side are whole, so that nothing can be said of the way in which the point is formed; there is, however, certainly no skin-bag round the point. This species must probably form a separate genus. As, however, no quite sufficient characterization can be given of it here, I shall propose no name for it, but be contented with having pointed out that it has no relation to *C. gracilis*.

The specimen from st. 184 has tridentate pedicellariæ somewhat recalling those of *Phormosoma*; but they are distinguished from the latter by the fact that the widenings from the upper end of the apophysis reach quite to the edge of the blade (Pl. XIII. Fig. 26); (in *Phormosoma* they, as stated above, end on the middle of the side of the blade.) The triphyllous pedicellariæ are similar to those of the specimen from st. 219. The stalk of the pedicellariæ of the common structure. The spicules are lengthened, narrow plates, arranged in 2—3 longitudinal series; no sucking disk is found. On the actinal side the tube feet are arranged in a single regular line (on the abactinal side the arrangement was indistinct in the specimen). All the primary spines on the actinal side are broken, so that the form of the point cannot be decided. — That this species has no relation to *C. gracilis* or to the specimen from st. 219 is evident. It seems to be nearly related to »*Ph.*» *tenue*, and would then have to be referred, together with this latter, to the genus *Echinosoma*. (See farther down p. 57.)

Although in the text Agassiz expresses a strong doubt whether the two species here mentioned, be really »*A.*» *gracilis*, he nevertheless afterwards cites the stations from which they have been obtained, among the localities of this species without adding any interrogation; this way of proceeding is very objectionable — and this is, unfortunately, not the only case. I shall express no opinion whether the specimen(s) from st. 169 is really *C. gracilis*, as I have not seen it. It is not to be relied upon with certainty, until the pedicellariæ etc. have been examined.

»*Asthenosoma*» *fenestratum* Wyv. Thomson is by Bell (72, 73), and Koehler (229) thought to be synonymous with »*A.*» *hystrix*. It has also to be admitted that there is a striking similarity as to habitus between the two species; but a closer examination of the pedicellariæ shows that the question is so far from being of one species, that they will even have to be referred to different genera. — There are three kinds of pedicellariæ, tetradactylous, tridentate, and triphyllous ones. The tetradactylous ones, which have been so excellently described and figured by Wyv. Thomson (»Porcupine» Echinoidea. Pl. LXVII. Figs. 5—6), are something quite unique among the Echinids, and consequently an excellent character of this genus. Bell (72), to be sure, thinks it to be an abnormal form of pedicellariæ, as he has not been able to find it in the numerous specimens he has examined. As, however, I have succeeded in finding this form also in *A. coriaceum* Ag., there can, of course, be no doubt

that it is a normal form of pedicellariæ characteristic of this group of species. Of tridentate pedicellariæ two kinds are found. The larger form has not been seen by Wyv. Thomson, but I have found it on a fragment kept in British Museum under the name of *Calveria Phormosoma*, but being undoubtedly an original specimen of Wyv. Thomson's *Calveria fenestrata*. The edges of the blade are much involuted, only the point is widened and deeply indented in the edge (Pl. XIV. Fig. 32). The valves are highly curved outward, so that they are wide apart when the pedicellaria is shut. The length of the head up to 2mm. The other form is very varying according to its size (Pl. XIV. Figs. 8, 17, 18, 24). Larger specimens recall to some degree the large form, but the widened part of the blade is comparatively larger, the involuted part smaller; the edge of the widened part is coarsely sinuate. When the pedicellaria is shut the valves are only a little apart (the figure by Wyv. Thomson. Pl. LXVII, 7). In the very smallest ones only a quite small space below is involuted, and the edge of the upper part is quite straight. All transitions between these forms are found, so that they can only be interpreted as modifications of one kind. Their neck is short, the stalk of the common structure. The triphyllous pedicellariæ have the cover-plate much developed, and are lengthened and narrow; the edge finely serrate (Pl. XII. Fig. 33). The primary spines on the actinal side are curved and end in a little hoof. The tube feet as in *C. hystrix* arranged in three separated series; the spicules large, irregular fenestrated plates, in the lower part of the tube foot arranged in four separated series; the sucking disk well developed. As characteristic of this species Wyv. Thomson lays stress on the large membranous interpaces between the plates; as Bell (72) has shown that this feature is very varying this character is not reliable. For the present there is no other sure character than the pedicellariæ, and even if the tetradactylous ones be wanting, which seems most frequently to be the case, be it now that they have fallen off, or perhaps may be quite wanting in some individuals, the tridentate pedicellariæ are sufficiently characteristic, so that no confounding can take place between this species and *Calveria hystrix*. A separate genus must be formed for this species; I propose the name of **Aræosoma**[1]). — No doubt it is this species that Agassiz (6) described as *Asthenosoma Reynoldsii*, but later (9) retired as a synonym of *A. hystrix*.

To this genus will further have to be referred *A. coriaceum* Ag. Of this species I have examined a specimen from Chall. st. 169. This station is not enumerated by Agassiz as a locality of the species, but according to the statement of Prof. Bell the determination of the animal has been made by Agassiz, so that it may be taken to be due to an omission that this station has not come in. — The tetradyctylous pedicellariæ agree exactly with those of *A. fenestratum*, so that no specific difference seems to be found in this structure. They were only found on the upper side, and only a few ones, as it was almost rubbed off. Of the tridentate pedicellariæ I have not found the largest form. The smaller form (Pl. XIV. Fig. 5) is especially highly developed, the head up to 2mm long. The blade is filled by a very complicated net of meshes, more developed than in *A. fenestratum*. As in this latter, forms are also here found with almost straight edge, as well as such as are rather similar to the large involuted form, and all transitions between them. Triphyllous pedicellariæ chiefly of the same form as in *A. fenestratum* (Pl. XII. Fig. 27). (The form figured of *A. fenestratum* with the cover-plate open in the median line, is not constant; they are as commonly found with the projections

[1]) ἀραιός — thin.

coalesced, so that a series of large holes is found along the median line — and they may also be found of the form, figured of *A. coriaceum*). The pedicellariæ (the tridentate ones) with short neck; the stalk of the common structure. The tube feet in three series. The spicules (Pl. XI. Fig. 15) are not so compact fenestrated plates as in *A. fenestratum*, the holes are much larger and fewer. In the lower part of the tube foot the spicules are more narrow, at last only fine, thorny, irregular needles, often a little widened as small fenestrated plates in one end or in both ends, or they have a larger hole in the middle. Below they seem to be arranged in four longitudinal series, above they inclose the whole foot as a close mail. The sucking disk well developed in the actinal tube feet. The primary spines on the actinal side form a very conspicuous, regular series along the outer edge of the interambulacral areas; in the ambulacral areas only 5—6 large spines are found scattered on the outer plates. They are curved, and end in a little hoof. Resembling more nearly the primary spines of *Phormosoma* than the characteristic flaring trumpet-shaped spines of *Asthenosoma* , Agassiz says of these spines (Chall. Ech. p. 88). As his *Phormosoma* contains so widely different forms as *Ph. placenta* and *hoplacantha* this statement gives no clear information; the meaning of it is that they are similar to those of *A. fenestratum*; the hoof is little, short, and broad.

Agassiz says of this species that it is «allied to *Asthenosoma grubii* in having an extremely thick leathery cuticle» (l. c.); according to the informations given here there is no nearer relation between these two species. Agassiz further thinks that it is «quite possible.... that this may be the adult of *Asthenosoma tessclatum*» (l. c.). After having examined the type specimen of this species I can say with certainty that this is not the case; the two species are not even so very nearly related even if they possibly belong to the same genus. — Tetradactylous pedicellariæ have not been found in this species. The tridentate pedicellariæ occur in two forms, between which there seem to be no transitions. The large form is quite similar to the large tridentate pedicellariæ in *A. fenestratum* (Pl. XIII. Fig. 5); the smaller form (Pl. XIII. Fig. 6, Pl. XIV. Fig. 15) is very peculiar, the blade deep, filled by a rich net of meshes, and with a highly irregular edge without such large sinuations as are found in *A. fenestratum* and *coriaceum*; the widenings from the upper end of the apophysis continue directly into the edge of the blade. When the pedicellaria is shut, the edges join completely, there is only at the basal part a small open space. This form is a little more long-necked than usual. The triphyllous pedicellariæ are quite similar to those of *A. fenestratum* and *coriaceum*; the stalk of the pedicellariæ of the common structure. Spicules and sucking disk as in *A. fenestratum*; the tube feet in three series. All the primary spines on the actinal side are broken in the only specimen known, so that it is impossible to say anything of the form of the point; surely, however, they are not skin-covered. — For the present it is impossible to decide whether this species is to be classed with *A. fenestratum* and *coriaceum*; but several things speak in favour of this supposition, and it will therefore be most correct provisionally to refer this species to the genus *Araeosoma*. That the membranous interspaces between the plates are especially large in this species speaks, of course, only in favour of the supposition that it really belongs to this genus.

Among the specimens kept in British Museum under the name of *Asthenosoma hystrix*, a piece was found (from Barbados, 137 fathoms), which is no doubt a new species, and probably also belongs to this genus. It is very similar to *Calveria hystrix*, but is of a darker colour (brownish violet).

Tetradactylous pedicellariæ have not been observed. Of tridentate pedicellariæ three kinds are found, with no transitions between them. The first form resembles that in *A. fenestratum*, but is finer and more slender (Pl. XIII. Fig. 22); the head 1mm. The second form (Pl. XIII. Fig. 10), which corresponds to the second form in *A. fenestratum*, is very large, the head 2mm. The blade much involuted; the widened part of the point rather large, coarsely sinuate in the edge. The valves only slightly curved, and accordingly the pedicellaria when shut has a peculiar lengthened appearance. The third, smallest form is very characteristic, with involuted edge and the outer end widened, without large curves in the edge (but with fine serrations) (Pl. XIII. Fig. 11). Triphyllous pedicellariæ of the same kind as in the other species, only more slender (Pl. XII. Fig. 29). The stalk of the pedicellariæ of the common structure. Spicules as in *A. fenestratum*, in two well-separated series to the very point. Well-developed sucking disk. — For this species I propose the name of **Aræosoma Belli** n. sp.

Asthenosoma» pellucidum A. Ag. Of this species, which is easily recognised as well by its whole habitus, as by its light spines with red bands, Agassiz says (Chall. Ech. p. 87): Unfortunately, the largest specimens of *Asthenosoma pellucidum* are so much smaller than the smallest *Asthenosoma coriaceum* or the single specimen of *Asthenosoma tesselatum*, that I am unable so satisfy myself that the present species (*Asthenosoma pellucidum*) may not be the young of *Asthenosoma coriaceum*. In the only species of the group of which the Challenger collected a complete series (*Phormosoma tenue*) there was little difficulty in recognising the young as belonging to the adult». We could scarcely wish to find a more pregnant proof of the difficulty or impossibility of determining Echinids without taking the pedicellariæ into consideration. *Asthenosoma pellucidum* is so far from being identical with *A. coriaceum* or *tesselatum*, that it must form a separate, very well characterized genus, and with regard to the excellent long series of *Phormosoma» tenue*, there are among the specimens referred to this species by Agassiz at all events two different genera, but no genuine *Phormosoma*!

In *A. pellucidum* three different kinds of pedicellariæ are found, viz. globiferous, tridentate, and triphyllous ones. The globiferous pedicellariæ are of a quite unique[1]) form (Pl. XII. Figs. 8—10, Pl. XIII. Figs. 20, 24, 25); they cannot be opened as other pedicellariæ, the three glandular bags are inclosed in a common skin, and open in the point, each through a separate pore. The valves are situated between the glandular bags; they are simple rods, slightly bisected in the point, a little hollow on the inside, and with a rather strong articular surface below. No apophysis is found, and no muscles seem to pass between the valves, what would not be of much use neither, on account of their being quite wrapped by the common bag of skin; they are far from reaching to the point of the pedicellaria. The tridentate pedicellariæ resemble to a high degree the pedicellaria of *Ph. tenue* figured by Agassiz (Chall. Ech. Pl. XLII. Fig. 7). The construction of the blade, however, is rather different: here only a little developed net of meshes is found, and the apophysis is not prolonged (Pl. XIV. Fig. 9), in *Ph. tenue* there is a rather well developed net of meshes, and the apophysis continues some way into the blade as a conspicuous, serrate crest. Only one form of tridentate pedi-

[1]) By a cursory examination one might be inclined to compare them with the «Globiferen» of *Centrostephanus longispinus* described by Hamann (184). This, however, cannot be done, at all events not for the present; perhaps the head of these modified globiferous pedicellariæ will show a structure recalling the form described here. But of this, I think, we know nothing. The large glands of the stalk in the globiferous pedicellariæ in *Centrostephanus* cannot, of course, be compared with the glands in the head of the pedicellariæ of *A. pellucidum*.

cellariæ is found, the large and small ones being upon the whole constructed in the same way. They are finely serrate in the edge. The neck long, the stalk of the common structure. The length of the head up to 1·5mm. The triphyllous pedicellariæ of a very fine form, with well-developed cover-plate, without holes (always?), and the edge beautifully serrate (Pl. XII. Fig. 14). — The spicules are in the lower part of the tube foot almost rod-shaped, with a few holes in the middle (Pl. XI. Fig. 19); they are placed in two series, across the longitudinal axis of the foot. In the upper part of the tube foot they are larger fenestrated plates; the sucking disk well developed. The tube feet in three series, beautifully trigeminate as in an *Echinus*. The primary spines on the actinal side curved, with a rather long hoof almost not thicker than the spine. Besides the characters mentioned here, there seem to be found good characters in the structure of the test and in the apical area; with regard to these characters the reader is referred to the description by Agassiz. It is evident that this species cannot be referred to any of the other genera; especially characteristic are the globiferous pedicellariæ, to which nothing corresponding is known in other Echinothurids. It must form a separate genus, for which I propose the name of **Hapalosoma**[1]).

Of the species that have been referred to *Asthenosoma*, the two species *A. longispinum* and *Iijamaï* from Japan described by Yoshiwara (448), are still left to be mentioned. Of these nothing can for the present be said with certainty; *A. longispinum*, however, seems to be a *Calveria* or an *Araeosoma*.

Phormosoma tenue A. Ag. (A specimen from Challenger st. 237 examined). The tube feet are placed very close together, forming only one almost regular series. The spicules highly developed, irregular fenestrated plates. There is no distinct sucking disk, only some irregular, slightly branched or unbranched continuations passing from the outermost fenestrated plates of the foot into its point. The primary spines on the actinal side ending in a little hoof. Only tridentate and triphyllous pedicellariæ are found. Of tridentate pedicellariæ a larger and a smaller form are found. The larger form (of which a rather good figure is found in Chall. Ech. Pl. XLII. Fig. 7, and Pl. XLIV. Fig. 19) has a rather rich, coarse net of meshes in the lower part of the blade, and the upper end of the apophysis continues somewhat into the blade as a serrate crest (Pl. XII. Fig. 35). This crest is not distinctly seen in the figure in Chall. Ech. (Pl. XLIV. Fig. 19), possibly it may not be a constant feature. The length of the head up to 2·8mm. The smaller form (the head up to 1mm) reminds much of those in *Ph. placenta*, but the contour is somewhat different, and the widenings from the upper end of the apophysis reach to the edge of the blade (Pl. XII. Fig. 40). The neck is long, also in the larger form, the stalk of the common structure. The triphyllous pedicellariæ have a well developed cover-plate; the edge finely serrate. — I have not found the peculiar two-valved, bottle-shaped pedicellaria figured by Agassiz (Chall. Ech. Pl. XLIV. Fig. 21). As it is two-valved, it may be taken to be an abnormity. It is, no doubt, a modification of the triphyllous pedicellariæ. This I also take to be the opinion of Agassiz when he says (op. cit. p. 82), that perhaps it is only a modification of «the remarkable long-pronged pedicellariæ figured by Thomson as characteristic of the group[2]). — In the description of this species

[1]) ἁπαλός = soft.

[2]) A few lines lower down in the same paragraph Agassiz seems to derive this form from the tridentate pedicellariæ (see above p. 46).

Agassiz (p. 96) mentions the pedicellariæ as long stemmed with a small head articulating with a second stem, from twice to three times the length of the head. This sounds very mysterious, and the figure, to which reference is made (Pl. XVIII. a. Fig. 11), gives no clear information — the pedicellaria figured there seems to be a quite common well-made one. May not this second stem possibly be the neck? A second kind of pedicellaria with an inverted conical head, and a comparatively stouter joint articulating upon a long stem is seen from the figure to be, in spite of this remarkable description, a quite common triphyllous pedicellaria. Still a third kind of pedicellariæ with a shorter articulation and a large head is mentioned; to judge from the figure it must be the same kind as the one with the remarkable second stem, and they seem both of them to be the smaller form of tridentate pedicellariæ. To be sure, the similarity is not striking, and it may also be possible that they belong to a quite different species, which has wrongly been referred to *Ph. tenue*. The large form of tridentate pedicellariæ is not at all mentioned in the description. — The longitudinal muscles are well-developed, organs af Stewart seem not to be found. By its spines, pedicellariæ, and the structure of the test (the actinal side only little different from the abactinal side) this species is distinctly distinguished from the genus *Phormosoma*. It must form a separate genus, and must get the name of *Echinosoma* proposed by Pomel (324) for this species and *Ph. uranus*, although this name is not especially significant for these species the test of which is so very soft and thin, and which are only provided with uncommonly few spines.

Of the Echinothurids referred by Agassiz to *Ph. tenue* I have examined a specimen from Chall. st. 272. It proved to belong to a quite different genus together with *Ph. Asterias* A. Ag., under which species it will be more nearly mentioned. On the label was found a point of interrogation, but of this doubt nothing is said in the text, and st. 272 is given without any reservation as a locality of *Ph. tenue*.

The above mentioned specimen from Chall. st. 184, which is by Agassiz referred to *Asthenosoma? gracilis*, is no doubt very nearly allied to *Echinosoma tenue*. Of the large form of pedicellariæ I have, unfortunately, only seen one broken specimen, by which it was not to be decided with certainty whether the apophysis continues into the blade as a crest. The smaller form of pedicellariæ is very similar to those of *Ech. tenue*; the triphyllous pedicellariæ are a little narrower than in this species, but agree with it in the development of the cover-plate. Also the spicules are a little narrower than in *Ech. tenue*; no sucking disk; the tube feet in one almost regular series. There can scarcely be any doubt that it is a species of the genus *Echinosoma*, and, moreover, a new species. As I can give no sufficient description of it, I shall give no name to it.

Phormosoma? uranus Wyv. Thomson is, no doubt, most nearly allied to *Ech. tenue*, as also observed by Agassiz (Chall. Ech. p. 103). Only 3—4 large primary spines are found in each side of the ambulacral and interambulacral areas on the actinal side at the ambitus, otherwise only scattered small spines. All the primary spines are broken on the type specimen of Wyv. Thomson, but no doubt they are provided with a little hoof in the point as in *Ech. tenue*. The tube feet on the actinal side are arranged almost in one series $\left[\begin{smallmatrix}\cdot\\\cdot\\\cdot\end{smallmatrix}\right]$, only a few outside of it. Of the tridentate pedicellariæ I have only found the smaller form (Pl. XII. Fig. 36). (The head up to 1^{mm}); they resemble very

much those of *Ech. tenuc*, and almost still more those of *Ph. placenta*. The widenings from the upper end of the apophysis reach most frequently, to be sure, to the edge of the blade, but they end rather often quite down at the side as in *Ph. placenta*. In the triphyllous pedicellariæ (Pl. XII. Fig. 17) the cover-plate is well developed, the edge finely serrate. There can scarcely be any doubt that also this species will have to be referred to the genus *Echinosoma*.

In the description of «*Phormosoma*» *uranus* (loc. cit.) Agassiz uses the expression «the only specimen collected», but nevertheless puts down for it two different localities, st. 6 and st. 78. This riddle I am able to solve. In British Museum a quite small Echinothurid is found from Chall. st. 78, determined by Agassiz as *Ph. uranus?*? On this basis st. 78 is named without any reservation as a locality of «*Ph.*» *uranus* (comp. *Calveria gracilis* and *Echinosoma tenue*). With regard to this specimen, it is otherwise very badly preserved, and not a single pedicellaria is kept. It is quite indeterminable, and consequently it cannot be considered to be correct to figure details of this specimen under the name of *Phormosoma uranus* (without any interrogation), as has been done by Agassiz (Chall. Ech. Pl. XVIII. c. Fig. 12).

The description of «*Ph.*» *uranus* given here does not at all agree with the excellent description given by Koehler (229). The incongruity arises from the fact that the species described by Koehler is no *Ph. uranus* at all. As I have examined the type specimen of Wyv. Thomson and also a specimen of the species Koehler has had before him, I am able to express myself with absolute certainty.

In the preliminary report of the Echinids from «Blake» (6) Agassiz establishes a new species under the name of *Phormosoma Petersii*, and describes it as «a species with an extremely thin test, and one which, when alive, is greatly swollen, assuming a nearly globular outline. It is of a brilliant light claret color. As in *Ph. uranus*, there is but little difference between the spines of the actinal and abactinal surfaces. The coronal plates of this species are more numerous than in any other species of the genus» (p. 76. op. cit.). In the final report of the «Blake»-Echinids (9) Agassiz states *Ph. Petersii* to be synonymous with *Ph. uranus*. Although the form he called *Ph. Petersii*, «differed very strikingly» from the specimen of Wyv. Thomson, he thinks now, after having got a specimen from the Faröe-Channel of a size between the type specimen of *Ph. uranus* and the «Blake»-specimens of *Ph. Petersii*, that «the differences which had been noticed between them were merely due to age, and that in this species the great development of the large primary tubercles of the actinal surface takes place at a late period of growth».

Koehler mentions a specimen of this «*Ph. uranus*», which he has got from the Smithsonian Institution (from «Albatross»), and by which he has determined his specimens as *Ph. uranus*. Our museum has also from Smithsonian Institution received a specimen of this «*Ph. uranus*», which is identical with the form more nearly described by Koehler. Now the question is whether this form is really identical with the original *Ph. Petersii* of Agassiz. The expression above quoted from the first note of *Ph. Petersii*: «there is but little difference between the spines of the actinal and abactinal surfaces» does in no way agree with the species of Koehler, in which the spines of the actinal side have a large, conspicuous hoof. It is possible, however, that they may have been broken in the specimens of Agassiz, and in this case there is really not much difference to be seen between the spines

of the actinal side and those of the abactinal side. (Our specimen is exactly in this condition). It does not appear from the habitus figures given by Agassiz and Koehler that it is the same species — but as Agassiz only figures the abactinal side, Koehler only the actinal one, the figures do not disprove the identity either. On the other hand, the detail-figures seem to agree, especially with regard to the arrangement of the pores which is rather characteristic. I therefore think it very probable that the species of Koehler is really identical with the *Ph. Petersii* of Agassiz, which latter is accordingly in no way synonymous with *Ph. uranus* Wyv. Thomson.

This species is distinguished by the following characters. The tube feet are placed on the actinal side in one almost regular series, on the abactinal side they are placed in three series very close together. The spicules are irregular fenestrated plates that do not seem to be arranged in longitudinal series; no sucking disk. The primary spines on the actinal side curved, with a large hoof. Only tridentate and triphyllous pedicellariæ are found. Of tridentate pedicellariæ only one form is found, with involuted edge, and the outer part widened in a spoon-like way, with straight and finely serrate edge (Pl. XIII. Figs. 8, 13). It is found of different sizes, up to 1^{mm} (the length of the head). The neck rather long, the stalk as usual. (A figure of the whole pedicellaria is given by Koehler (op. cit. Pl. IX. Fig. 49)). The triphyllous pedicellariæ with well developed cover-plate with many small holes; the edge finely serrate (Pl. XII. Fig. 42). The organs of Stewart well developed. — It is evident that this species cannot be referred to any of the preceding genera; it must form a new genus, for which I propose the name of **Hygrosoma**[1]), and its name will then be *Hygrosoma Petersii* (A. Ag.).

«*Phormosoma*» *hoplacantha* Wyv. Thomson seems to be very nearly allied to this species. Its whole exterior is quite like it; the spines have a similar large, white hoof, and the primary spines are arranged in the same way as in *H. Petersii*; also the tube feet are arranged quite as in the latter species. Of pedicellariæ only a large tridentate form is known, figured by Agassiz (Chall. Ech. Pl. XLIII. Fig. 1, and Pl. XLIV. Fig. 29). It seems to be very similar to the above described form in *H. Petersii*. Although I have not examined the pedicellariæ of this species, I do not doubt that it belongs to the same genus as *Hygrosoma Petersii* — the difficulty is rather to state any difference between the two species. To judge by the figures of Agassiz, the pedicellariæ, however, seem to differ somewhat from those of *H. Petersii*, so that presumably specific characters will be found in these structures. As *H. hoplacantha* has only been taken in the Pacific (at Australia, Japan, and Juan Fernandez), and as *H. Petersii* is only known from the Atlantic, there can scarcely be any doubt that they form two well distinguished species.

No doubt «*Phormosoma*» *luculentum* A. Ag. is nearly allied to these two species. As in these the spines of the actinal side end in a large, white hoof. The tube feet are arranged in the same way; the spicules are rather large, irregular fenestrated plates, somewhat indistinctly arranged in two series. A rather well developed sucking disk is found. The tridentate pedicellariæ (Pl. XIII. Fig. 14) are very much similar to those of *Hygrosoma Petersii*; the triphyllous ones (Pl. XII. Fig. 20) are of a somewhat different form, but otherwise with large cover-plate and serrate edge as in *H. Petersii*. But besides these forms still a very peculiar kind of pedicellariæ is found (Pl. XIII. Fig. 16), which is, no doubt, a modified form of tridentate pedicellariæ. The valves are very broad, constricted in the middle.

[1]) *ὑγρός* — elastic.

The blade is filled by an exceedingly dense and complicated net of meshes. In the figures of Agassiz (Pl. XLIV. Figs. 25—26, Chall. Ech.) this net of meshes is not seen, but otherwise these figures give a good representation of the single valve. The length of the head 1·5mm, the neck very short, the stalk thicker and stronger than usual, with a constriction above. They seem only to be found on the actinal side. Agassiz further figures (Pl. XLIV. Fig. 27) a single valve of a «small short-headed, shortstemmed pedicellaria», which seems to be an ophicephalous one. This form I have not found in the specimen I examined in British Museum (Chall. st. 200); but as, at the time, I had not noticed the mentioned figure, I have not, of course, made any special search for it, and so I dare say nothing of it. If this species should thus prove to be possessed of two kinds of pedicellariæ, to which nothing corresponding is found in any other known Echinothurid, there might be some reason to establish a separate genus for it. For the present, however, I think it most correct to refer it to the genus *Hygrosoma*, as in so many important structures it agrees exactly with the other species referred to this genus.

The last of the Echinothurids described from «Challenger», *Phormosoma asterias*, differs to a high degree from all the others; to be sure, its peculiarities do not appear from the description of the species by Agassiz (Chall. Ech. p. 104), but his figures give more information, and the examination of the type specimen in British Museum revealed still more interesting features. — The ambulacral areas show the quite unique feature that the small secondary ambulacral plates are wanting; there is only one tube foot for each ambulacral plate. Thus only a single series of tube feet is found, and the distance between the feet is rather large. This highly interesting feature is seen very well on the figures of Agassiz (Pl. XII. a. Figs. 8, 9); in the description he only says that «the course of the poriferous zone is quite sporadic». (It is a matter of course that this very interesting feature ought to be examined exactly, as it is possible that traces may be found of the secondary ambulacral plates and their tube feet.) The spicules are lengthened, narrow, with few or no holes (comp. Pl. XI. Fig. 18); they are arranged parallel to the longitudinal axis of the foot, in 2—3 well separated series; in the outer part of the foot they may join completely. No sucking disk is found. — The spines are of a quite peculiar structure, that is to say they are flat and broad towards the point (Pl. XIV. Fig. 29). I can give no information whether a hoof is found on the point of these spines or on other spines of common form, as I have not made sufficient notes on this fact. The pedicellariæ are not less peculiar. The blade of the tridentate pedicellariæ (Pl. XIII. Fig. 9) is rather flat, with a more or less well developed, perforated cover-plate below reminding of that in the triphyllous pedicellariæ. The point is hastately cut off, a little widened, with finely dentate outer edge; the apophysis and the lateral edges more or less thorny. In the triphyllous pedicellariæ the cover-plate is very slightly developed, highly perforated (Pl. XII. Fig. 12). The edge shows only very slight indications of teeth, so that they are only to be seen under especially high magnifying powers. The stalk of the pedicellariæ is quite different from that of all other Echinothurids, as it consists of long, thin calcareous threads, almost without any connection except in the upper and lower end of the stalk — as in an *Echinus*. It is evident that this species cannot be referred to any of the other genera; it must form a separate genus, for which I propose the name of **Kamptosoma**[1]).

[1]) *κάμπτω* — bend.

To this genus belongs further one specimen (or more?) from Chall. st. 272 determined by Agassiz as *Phormosoma tenue?* — The spicules (Pl. XI. Fig. 18) are as in *K. asterias* and arranged in the same way; no sucking disk. I can give no information of the fact whether the spines are as in *K. asterias*, as I have no notice of this feature. The pedicellariæ are very similar to those of *K. asterias*, but here moreover a larger form of tridentate pedicellariæ is found (Pl. XIII. Figs. 15, 21), which I have not seen in the type specimen of *K. asterias*. As, however, the pedicellariæ agree otherwise so exactly, it may be supposed that this form will also be found in *K. asterias*. This larger form of pedicellariæ is chiefly constructed as the smaller one; the cover-plate has only a few holes in the median line, or is quite open the edges not joining completely. The point is a little widened, broadly hastate, with exceedingly finely serrate edge; (as in the triphyllous pedicellariæ the serrations are only to be seen under very high magnifying powers); the holes in the blade are beautifully arranged in curved series. They are very long-necked; the head up to 0·8^{mm}; the stalk is of the structure characteristic of the genus *Kamptosoma*. The smaller form of tridentate pedicellariæ resemble to a high degree those of *K. asterias* the only difference being that the apophysis and edges have no thorns. The triphyllous pedicellariæ are somewhat shorter and more arched than those of *K. asterias*, but they have the same peculiar cover-plate, and the serrations of the edge are likewise exceedingly slight. — There can be no doubt that this species also belongs to the genus *Kamptosoma*; but it may be doubtful whether it is a separate species, or identical with *K. asterias*. The small differences in the pedicellariæ are suggestive of its being a distinct species; but this question cannot be decided with certainty, till a direct comparison of the two specimens has been made.

Now we have only left two of the species referred to *Phormosoma*, viz. *Ph. panamense* A. Ag., and *Ph. hispidum* A. Ag. As to the former it has been supposed above that it may be a genuine *Phormosoma*, of the latter nothing at all can be said. Both species have only been preliminarily and very incompletely described.

The genus *Sperosoma* established by Koehler (228, 229) is especially characteristic by the peculiar construction of the ambulacral areas on the actinal side. The secondary ambulacral plates are of about the same size as the primary ones; the primary ambulacral plate is divided into an outer part, in which the pore is found, and an inner part. Thus on the actinal side the ambulacral area consists of 8 series of plates. The tube feet are placed in three widely separated series. The spicules are large fenestrated plates, not arranged in series; there is a well developed sucking disk (Pl. XIV. Fig. 4). Only tridentate and triphyllous pedicellariæ are found. The tridentate ones (Pl. XIV. Figs. 2, 6, 33) remind somewhat of those in *Ph. placenta*, especially the small forms are only with difficulty to be distinguished from those; the widenings from the upper end of the apophysis do not reach to the edge of the blade. There is a rather coarse net of meshes in the bottom of the blade, slightly developed in the small forms, more developed in the larger ones, and in these latter it is set with thorns (Pl. XIII. Fig. 12.) The length of the head up to 2^{mm}, the neck rather short in the large ones; the stalk of the common structure. In the triphyllous pedicellariæ the cover-plate is rather slightly developed, with numerous small holes. The edge finely serrate. The primary spines on the actinal side curved, with a large, white hoof.

Besides the species of Koehler, *Sp. Grimaldii*, a species established by Döderlein (118), *Sp.*

biscriatum, has been referred to this especially well characterized genus; but it has not hithertho been more thoroughly described, so that for the present nothing can be said of this species.

One more genus will have to be established for a large Echinothurid obtained by the »Ingolf»-Expedition. The tube feet form one irregular series on the actinal side; the spicules irregular fenestrated plates not arranged in series; no sucking disk. The primary spines on the actinal side curved, with large hoof. Three kinds of pedicellariæ are found: tridentate, ophicephalous, and triphyllous pedicellariæ. The tridentate ones occur in two forms; in the larger form (length of the head up to $3{\cdot}5^{mm}$) the blade is filled by a coarse, very thorny net of meshes (Pl. XII. Fig. 41). The edges are not involuted; the outer part of the blade somewhat widened. The neck very short, the stalk of the common structure. The smaller form resembles those in *Ph. placenta*, but the widenings from the upper end of the apophysis reach to the edge of the blade. The ophicephalous pedicellariæ (Pl. XIV. Figs. 19, 23, 25) are very peculiar, the upper end of the valve being widened in a wing-shaped way, while the middle part is very narrow. The length of the head ca. $0{\cdot}5^{mm}$. The neck is quite short, contrary to the ophicephalous pedicellariæ of the Echinids, and the stalk is a thick, perforated tube. — As ophicephalous pedicellariæ, as far as hitherto known, are not found in other Echinothurids (perhaps they are found, however, in *Hygrosoma luculentum* (see above p. 59—60), but then they have quite another form) they yield an excellent character for this genus. In the triphyllous pedicellariæ the cover-plate is rather slightly developed, richly perforated (Pl. XII. Fig. 31). — For this genus I propose the name of **Tromikosoma**[1]).

According to these researches the system of the Echinothurids gets the following appearance:

Phormosoma Wyv. Thomson (emend.).

The primary spines on the actinal side straight, club-shaped, inclosed by a thick bag of skin; marked difference between the actinal and the abactinal sides. The areoles of the actinal side very large. The tube feet are arranged in a single series on the actinal side. The spicules large fenestrated plates; no sucking disk. Only tridentate and triphyllous pedicellariæ. The tridentate ones are simply leaf-shaped, with little developed net of meshes. The widenings from the upper end of the apophysis do not reach to the edge of the blade. The stalk of the pedicellariæ irregularly perforated.

Species: *Ph. placenta* Wyv. Thomson, *bursarium* A. Ag., *rigidum* A. Ag.

Distribution: Northern part of the Atlantic, Japan, the Philippines, New-Zealand. — Archibenthal forms.

Echinosoma Pomel (emend.).

The primary spines on the actinal side curved, with a little hoof at the point; the actinal and the abactinal sides look almost quite alike, only a few, large spines being found near the ambitus. The areoles large. The tube feet are placed in one almost regular series on the actinal side; the spicules large fenestrated plates, no sucking disk. Only tridentate and triphyllous pedicellariæ. Of tridentate pedicellariæ two forms are (always?) found, a large one, flat, with a rich net of meshes, and with the upper end of the apophysis continuing some way into the blade as a serrate crest, and a smaller one,

[1]) *τρομικός* — quivering.

simply leaf-shaped, with a little developed net of meshes. The stalk of the pedicellariæ irregularly perforated.

Species: *Ech. tenue* (A. Ag.), *uranus* (Wyv. Thomson).

Distribution: The Pacific, the northern Atlantic. — Abyssal forms.

Asthenosoma Grube (emend.).

Synonym: *Cyanosoma* Sarasin.

The primary spines on the actinal side curved, with a rather long, narrow hoof; rather great difference between the abactinal and the actinal sides, on account of the numerous primary spines covering the whole actinal side; the areoles are almost of equal size on both sides. The spines on the abactinal side inclosed by a thick, annularly constricted bag of skin. The tube feet form three dense series; the spicules small branched bodies, arranged in longitudinal series. Sucking disk well developed. Only tridentate and triphyllous pedicellariæ. The tridentate ones occur in three distinct forms. The largest form has a long, narrow blade, widened in the point where it is coarsely serrate (not observed in all the species); the second form has a short, broad, and flat blade filled by a rich net of meshes and with coarsely sinuate edge. The third form is simply leaf-shaped, with the apophysis continued to the middle of the blade, or quite to the point as a sharp, serrate crest. The stalk irregularly perforated.

Species: *Asth. varium* Grube, *Grubei* A. Ag., *urens* Sarasin, *heteractis* Bedford.

Distribution: Ceylon, the East-Indian Archipelago. — Littoral forms.

Calveria Wyv. Thomson (emend.).

The primary spines on the actinal side curved, ending in a little hoof; only a slight difference between the actinal and the abactinal sides. The areoles rather small. The primary spines form a rather conspicuous series along the outer margin of the interambulacral areas, especially towards the ambitus on the actinal side. The tube feet in three dense series; the spicules in the outer part of the tube foot larger fenestrated plates, in the lower part smaller and arranged in longitudinal series. Sucking disk developed. Only tridentate and triphyllous pedicellariæ. In the large form of tridentate pedicellariæ the blade is much involuted, only at the point a little widened, and the edge of this widened part is irregularly serrate. The smaller tridentate pedicellariæ chiefly of the same form, only the widened part of the blade comparatively larger, the involuted part smaller. The stalk irregularly perforated.

Species: *C. hystrix* Wyv. Thomson, *gracilis* (A. Agass.).

Distribution: The northern Atlantic, the Philippines. — Archibenthal forms.

Aræosoma n. g.

The primary spines on the actinal side curved, ending in a little hoof; only a slight difference between the actinal and the abactinal sides; the areoles rather small. The primary spines form a rather conspicuous series along the outer margin of the interambulacral areas, especially on the actinal side towards the ambitus. The tube feet in three dense series. The spicules larger fenestrated plates, in the lower part of the tube foot smaller, sometimes irregular needles, more or less distinctly arranged in longitudinal series. Sucking disk well developed. Besides the commonly occurring tridentate and

triphyllous pedicellariæ also tetradactylous pedicellariæ are found. The tridentate ones occur in 2—3 different forms. In one form the blade is highly involuted, only the point is widened, deeply indented in the edge. The second form has a shorter involuted part, and a comparatively larger widened point, with coarsely sinuate edge; in the smaller specimens of this form the edge of the widened part may be quite straight. (In one species (*A. tesselatum*) instead of this form a tridentate pedicellaria is found, in which the edge of the blade is not at all involuted, and the blade is filled by a coarse net of meshes; in another species (*A. Belli*) only (?) very large specimens are found of the second form, and here occurs moreover a third, smaller form with involuted edge and widened point the edges of which are not sinuate. — The position of these two species is somewhat uncertain). The stalk of the pedicellariæ irregularly perforated.

Species: *A. fenestratum* (Wyv. Thoms.), *coriaceum* (A. Ag.), *tesselatum* (A. Ag.) (?), *Belli* n. sp. (?).

Distribution: The northern Atlantic, the Viti Islands, the Philippines. — Sublittoral-archibenthal forms.

Hapalosoma n. g.

The primary spines on the actinal side curved, with a rather long, thin hoof; they form a regular, conspicuous series along the outer margins of the interambulacral areas, which series continues some way up on the abactinal side. The areoles not very large; no conspicuous difference between the actinal and the abactinal sides. The tube feet in three series — almost as in an *Echinus*. The spicules almost rod-shaped, above somewhat larger fenestrated plates, arranged in two series; the sucking disk well developed. Three kinds of pedicellariæ: globiferous, tridentate, and triphyllous ones. In the globiferous ones the glandular bags are quite wrapped in a common skin; they open in the point of the head each through a separate little pore. The valves, which are situated between the glandular bags, reach only half-way to the point. The tridentate pedicellariæ are simply leaf-shaped, with an only slightly developed net of meshes; only this form is found. The stalk of the common structure.

Species: *H. pellucidum* (A. Ag.).

Distribution: The Philippines, New Guinea. — Sublittoral form.

Hygrosoma n. g.

The primary spines on the actinal side curved, with a large, white hoof; they are scattered near the ambitus; the areoles large; the difference between the actinal and the abactinal sides rather great. The tube feet are arranged in one almost regular series on the actinal side. The spicules large fenestrated plates, no sucking disk. Only tridentate and triphyllous pedicellariæ. The tridentate ones occur only in one form, highly involuted; the point is widened in a spoon-like manner, and its edge is straight. The stalk of the pedicellariæ of the common structure. In one species, *H. luculentum*, another kind of tridentate pedicellariæ is found, with very thick and broad blades, almost as ophicephalous pedicellariæ; but the species cannot with certainty be referred here.

Species: *H. Petersii* (A. Agass.), *hoplacantha* (Wyv. Thoms.), *luculentum* (A. Ag.) (?).

Distribution: The northern Atlantic, the Pacific. — Sublittoral-archibenthal forms.

Tromikosoma n. g.

The primary spines on the actinal side curved, with a large hoof, they are only few and

scattered, and form no regular series; the areoles of a middle size; no great difference between the actinal and the abactinal sides. The spicules irregular fenestrated plates, not in series; the tube feet in one irregular series on the actinal side; no sucking disk. Three kinds of pedicellariæ: ophicephalous, tridentate, and triphyllous ones. The ophicephalous ones with the valves highly constricted in the middle, short neck, and tube-formed stalk. The tridentate ones occur in two forms, a larger one with leaf-shaped point, filled by a coarse, thorny net of meshes, not involuted; and a smaller one, simply leaf-shaped, with the widenings of the apophysis ending at the very edge of the blade. The stalk of the tridentate and the triphyllous pedicellariæ of the common structure.

Species: *T. Kochleri* n. sp.

Distribution: The Davis Strait. — Abyssal form.

Sperosoma Koehler.

The primary spines on the actinal side curved, with a large white hoof; they occur scattered; the areoles large. Rather great difference between the actinal and the abactinal sides. The secondary ambulacral plates on the actinal side of the same size as the primary ones; the ambulacral areas consist on the actinal side of 8 series of plates. The tube feet on the actinal side in three widely separated series. The spicules large, fenestrated plates, not arranged in series; sucking disk well developed. Only tridentate and triphyllous pedicellariæ. The tridentate ones are simply leaf-shaped; the widenings from the upper end of the apophysis do not reach to the edge of the blade; in the large ones the blade is filled by a coarse, thorny net of meshes. The stalk of the common structure.

Species: *Sp. Grimaldii* Koehler, *biseriatum* Döderlein.

Distribution: The northern Atlantic, the Indian Ocean. — Archibenthal forms.

Kamptosoma n. g.

The spines (at all events some of them) flat and widened towards the point; hoof (?); no great difference between the actinal and the abactinal sides. Secondary ambulacral plates seem to be wanting. The tube feet form a single series. Only tridentate and triphyllous pedicellariæ; in the tridentate ones the blade is flat with more or less developed cover-plate; a larger and a smaller form are found, only little different. In the triphyllous pedicellariæ the cover-plate is uncommonly slightly developed. The stalk consists of long threads almost only united at the ends.

Species: *K. asterias* (A. Agass.).

Distribution: The Pacific. — Abyssal form.

Incertæ sedis:

Phormosoma panamense A. Ag.

— *hispidum* A. Ag.

Asthenosoma longispinum Yoshiwara.

— *Iijamæ* Yoshiwara.

As has been done above in the Cidarids I shall also here expressly observe that I do not regard the generic diagnoses given here as complete. As well the structure of the test as the inner anatomy stands in need of an exact examination in several of the genera. I must, however, regard

all the genera established here as good ones, and also the limitation of the old genera *Phormosoma* and *Asthenosoma* is no doubt correct. Only the genera *Arœosoma* and *Hygrosoma* are perhaps still taken in too wide a sense, in as far as the species *A. tesselatum* and *Belli*, as also *H. luculentum* ought perhaps to be separated as particular genera; at all events, however, they are most nearly allied to the genera to which they are here referred.

In stead of the former confusion of species and the two genera that were not to be kept distinct, we have got a number of definitely characterized and easily recognisable genera — a result that has been obtained especially by a careful examination of the pedicellariæ. Thus it proves here as in the Cidarids to be a fact that the spines and the structure of the test are in no way a sufficient basis for the classification. Otherwise the spines play a prominent part in the classification of the Echinothurids, and by means of these alone a far better classification might have been obtained than the one expressed in the old genera *Phormosoma* and *Asthenosoma*.

For the present it must be left undecided whether there may be any question of a grouping of the genera into subfamilies. There is, however, no doubt that the genera *Phormosoma* and *Kamptosoma* are rather distantly allied to the other genera.

5. **Phormosoma placenta** Wyv. Thomson.

Pl. IV, Figs. 1—2. Pl. XI, Figs. 7, 10, 25. Pl. XII, Figs. 2—3, 7, 11, 19, 21, 23, 25, 26, 37, 39. Pl. XIII, Fig. 7.

Synonym: *Phormosoma Sigsbei* Agassiz.

Principal literature: Wyville Thomson: «Porcupine»-Echinoidea (395). p. 732. Pl. LXII—LXIII. — A. Agassiz: 6. p. 75. «Blake-Echini» (9) p. 30. Pl. XII, XV. Fig. 3—19. — E. A. Verrill: 418. p. 139. — W. E. Hoyle: Rev. List of Brit. Ech. (202). p. 406. — F. Jeffr. Bell: 69. p. 436—38. Catalogue of Brit. Ech. (73). p. 144.

This species has been so carefully described by Wyv. Thomson and Agassiz, that there is no reason to give here again a complete description of it. Only a few structures need still a more exact description, viz. the spines, the tube feet, and the pedicellariæ; some remarks must also be made with regard to the development and transformation of the apical area, as also with regard to the inner structure.

Of the spines on the actinal side of this species Bell (Catal. p. 144) says: «from what is known ... it is probable, that they are rather long and have a stout calcareous cap». This is wrong. Wyv. Thomson, to be sure, says (l. c.) that two kinds of spines are found, but what he describes and figures is only larger and smaller spines of the kind found on the abactinal side; the large spines on the actinal side have been broken in his specimens. Agassiz, in the description of *Ph. placenta* («Blake-Echini»), says nothing of the spines of the actinal side, but from his fig. 8. Pl. XII it is seen that they are club-shaped, and in the explanation of the figures they are called «clubshaped». In the diagnosis of *Ph. Sigsbei*, which, according to Agassiz himself, is synonymous with *Ph. placenta*, it is said: «primary radioles on the actinal surface resembling those of *Ph. bursaria*», and of these latter he says (Chall. Ech. p. 100): «on the actinal surface the primary spines are not tipped with a solid hoof, but all end in a fleshy bag». — Thus it may be seen, by comparing the several statements, to be sub-

stantiated in an indirect manner in the literature that the primary spines on the actinal side are inclosed in a thick bag of skin, and it may be seen rather easier on the animals themselves when they are fairly well preserved. — These bags of skin may possiby contain poison apparatus; at all events the living Phormosomes are said to sting when touched, and there seems to be no poison bags on the spines of the abactinal side.

These skin-covered spines are of a more complicated structure than the spines of the abactinal side; only at the base it may still be seen that they have originally been tubular as the other spines. They end in a broad serrate point (Pl. XII. Fig. 11). In transverse sections it is seen that they are tubular in the lower part with projecting, hollowed ridges (Pl. XI. Fig. 7 b); towards the point these ridges become much less conspicuous and quite irregular. At the same time the cavity is filled by an irregular net of meshes of fine calcareous threads running parallel to the longitudinal axis of the tube (Pl. XI. Fig. 10). The spines of the abactinal side, as is seen from the excellent figure by Wyv. Thomson (Pl. LXII. 3), are hollow tubes, very regularly perforated, and ending in a long, fine point. Most frequently, however, the thorns are both fewer and more feeble than in this figure. Transverse sections show that here no projecting longitudinal ridges are found (Pl. XI. Fig. 7 a). The spines on the peristome are covered in their whole length by a thick skin, but they have no bag-shaped widening in the point. The spines themselves are constructed as the primary spines of the actinal side, the only difference being that they are not widened at the point (Pl. XII. Fig. 19).

The expression of marginal fasciole, used by Agassiz of the close-sitting small spines at the ambitus (Blake-Echini. p. 34) is to be avoided, at all events for the present. Agassiz, to be sure, thinks that they take(s) almost the prominence of a fasciole, and are (is) interesting as showing how such a structure may exist in a rudimentary form in the Desmosticha (Chall. Ech. p. 98). I do not think that it recalls to any striking degree the fascioles of the Spatangids, and at all events we have for the present no safety that they are homologous formations. The expression of marginal fringe, used by Wyv. Thomson is therefore to be preferred, as it is quite without morphological pretensions.

Wyv. Thomson (op. cit. p. 735) states that the tube feet are provided with a sucker with a well-developed calcareous rosette of four or five pieces. This sucker I have not been able to find; according to my examinations all the tube feet, as well actinal as abactinal, end in a point, without sucking disk. The spicules, which are, as stated by Wyv. Thomson, irregular, larger or smaller fenestrated plates, are commonly arranged in 4 longitudinal series. This is especially distinct in the lower part of the tube foot; towards the point the plates become larger and arcuate, and at last they surround the foot as a mail. There is no great difference between the spicules of the tube feet of the actinal and the abactinal sides; they are only more slightly developed in the latter (Pl. XI. Fig. 25).

In young specimens of *Ph. placenta* the peculiar feature is found in the tube feet of the abactinal side that only the uppermost one of the three tube feet that correspond to each ambulacral plate, is well developed, while the other two are quite rudimentary. The same fact may also be found in large specimens, and it may at all events most frequently be seen that the uppermost one of each set of three tube feet (the one belonging to the inner one of the two small secondary ambulacral plates) is more developed than the others. In these rudimentary tube feet no spicules are developed; neither

are any spicules found in the skin on the outside of the plates (which may easily be prepared off) or in the bag of skin round the spines of the actinal side.

The pedicellariæ. The tridentate pedicellariæ occur only in one form, with simply leaf-shaped valves. The size is very different, from quite small ones to such where the head has a length of 2^{mm}. The form of the valves is rather varying, sometimes short, broad, and flat, almost without any net of meshes, sometimes long, narrow, and deep, or long and broad, with a rather well developed net of meshes at the bottom. On Pl. XII. Figs. 2, 3, 7, 26, 37, 39 some forms are given; all transitions between them are found; but narrow and broad forms do not seem to occur in the same individual, as in *Ph. bursarium*. The upper end of the apophysis is widened, but these widenings do not reach to the edge of the blade, they cease about midway on the side. Also the net of meshes at the bottom of the blade is an immediate continuation of the upper end of the apophysis; it is always smooth. The sides of the blade are most frequently a little bent outward, especially on the narrow forms. The edge is finely serrate, which is only to be seen under higher magnifying powers. The tridentate pedicellaria figured on Pl. XIII. Fig. 7, is the long, narrow form. The neck is rather long, the stalk is thin, irregularly perforated.

In some specimens from st. 40 the tridentate pedicellariæ are especially long and narrow (the pedicellaria figured on Pl. XIII. Fig. 7 is one of these), so that we might be inclined to regard these as a separate species or variety. As there seems, however, to be no other characters, — with the exception that the tube feet of the actinal side are more rudimentary than usual — and as the form of the pedicellariæ may be rather varying, there can scarcely be any question of regarding these specimens otherwise than as good *Ph. placenta*.

The triphyllous pedicellariæ have been excellently figured by Wyv. Thomson (Pl. LXII. Fig. 6), so I only figure one valve seen from the inside (Pl. XII. Fig. 21). The cover-plate is here very slightly developed, but in this feature some variation is found. The outer edge is finely serrate.

Sometimes two-valved pedicellariæ are found, especially tridentate ones, more rarely triphyllous ones. They are constructed as the normal three-valved pedicellariæ, and have an apophysis as these, only more slightly developed. It is rather interesting to compare these pedicellariæ with the normally two-valved ones in *Porocidaris*; in the latter the apophysis is quite wanting. I have found a few instances of a tridentate pedicellaria, in which the edge of the blade was a little involuted for a short space below, so that it reminded of the small tridentate pedicellariæ in *Araeosoma fenestratum*.

The sphæridiæ (Pl. XII. Figs. 23, 25) are commonly almost globular, but show too great variation to be reliable specific characters. As observed by Agassiz they are placed in a series along the tube feet from the mouth far up on the abactinal side.

According to Bell (69. p. 438) the longitudinal muscles are »altogether absent from *Phormosoma*». I cannot agree with Bell in this statement; they are also found in *Ph. placenta*, and are of the common form, but they are fine and break easily, so that the preparation must be made with great caution, in order to get a distinct view of them. I think it only little probable that any greater individual variation with regard to the development of the longitudinal muscles should be found in *Ph. placenta*, so that they might even sometimes be quite wanting. The organs of Stewart, as shown by Bell (op. cit.), are very little developed.

Agassiz (Blake-Echini. Pl. XV) has figured several stages of development of this species. As among the material of *Ph. placenta* collected by the Ingolf several small specimens are found, especially from st. 25 (the Davis Strait), I have been able to follow the development of the apical area, and have found that the description of this development given by Agassiz does not agree very well with what is shown by the specimens before me. Whether this is due to the fact that the figures given by Agassiz are inaccurately drawn, or perhaps a confounding with another species has taken place, I shall not try to decide. (The possibility of the West-Indian specimens of *Ph. placenta* being a special local form, seems to be excluded: some specimens from the Gulf of Mexico, which our museum has received from the Smithsonian Institution, agree exactly with those taken in the Davis Strait.) I shall only figure a couple of stages of the development of the apical area in the specimens in hand.

On Pl. IV. Fig. 2 the apical area of a specimen of a diameter of 7^{mm} is figured. Agassiz on Pl. XV. Fig. 3 figures the apical area of a specimen of a diameter of 8^{mm}. The difference between these two figures is rather conspicuous. In the specimen figured here the ocular plates have a peculiar, «spade»-like form, and the genital plates almost join inside of them, so that the ocular plates only just touch the anal area; the madreporite may already be distinguished. In the figure of Agassiz the form of the ocular and the genital plates is quite different, and the ocular plates reach far inside of the genital plates. On Pl. IV. Fig. 1 the apical area of a specimen of a diameter of 37^{mm} is figured. The development of small plates, partly at the cost of the genital and ocular plates, is here already rather advanced, the ocular plates, however, having still essentially kept the form characteristic of the younger stages. (In the adult animal this form is no more to be recognized.) Even if all possible transitional stages between the two figured here were not found, there could scarcely be any doubt that they are developmental stages of the same species. The peculiar small, oblong plates in the skin of the region round the anal opening, begin already to appear in specimens of a diameter of 15^{mm}. (They have here been drawn a little too regular.) Agassiz (Pl. XV. Figs. 9 and 11) figures the apical area of specimens of a respective diameter of 28^{mm} and 41^{mm}. The resemblance to the figures given here is not striking; but the figures are rather indistinct, so that it is difficult to compare the details of the two sets of figures. Further Agassiz (Pl. XV. Fig. 5) figures the apical area of a *Ph. placenta* of a diameter of 17^{mm}; this figure agrees as badly with a specimen of 17^{mm} now before me, as does the figure 3 of Agassiz with the apical area of a specimen of 7^{mm} figured here. — A comparison of these two figures in Agassiz (Figs. 3 and 5) conveys the direct impression that they do not belong to one species. But whatever the case may be with regard to these figures, it is a sure fact that the specimens before me are really *Phormosoma placenta*. It is still to be observed that the figures given here have been drawn from dried specimens; in specimens in spirit it is generally impossible to see the limits between the plates distinctly.

A large material of this species has been obtained by the Ingolf-Expedition on the following stations:

St. 24.	(63° 06′	N. Lat.,	56° 00′	W. L.	1190 fms.	Mud.	2° 7	bottom temp.).	1	specimen.
— 25.	(63° 30′	—	54° 25′	—	582	—	3° 6	—).	167	—
— 28.	(65° 17′	—	55° 42′	—	420	—	3° 8	—).	27	—
— 40.	(62° 00′	—	21° 36′	—	845	—	3° 9	—).	5	—
— 63.	(62° 40′	—	19° 05′	—	800	—	4° 3	—).	2	—

St. 69.	(62° 40′ N. Lat.,	22° 17′ W. L.	589 fms.	Mud.	3° 9	bottom temp.).		1	specimen.
— 73.	(62° 58′ —	23° 28′ —	486 —	—	5° 1	—	).	3	—
— 76.	(60° 50′ —	26° 50′ —	806 —	—	3° 7	—	).	1	—
— 83.	(62° 25′ —	28° 30′ —	912 —	?	3° 1	—	).	3	—

From previous collections we have some specimens from the Davis Strait (66° 49′ N. Lat., 56° 28′ W. L. 235 fathoms. Wandel).

Phormosoma placenta is distributed over the whole northern part of the Atlantic, from the West Indies to the Davis Strait, from the Bay of Biscay to the Faröe Islands and Iceland. It has been taken on depths from 150—1356 fathoms (Bell Catalogue, Hoyle 202, Rathbun 337), but it seems chiefly to be found on ca. 400—1000 fathoms. Koehler (226. p. 91) also observes that it is «rélativement rare dans les dragages profonds». It is an archibenthal form scarcely occurring on the great depths in the Atlantic, but limited to the territories of the mentioned depth that stretch across the Atlantic south of Iceland and then follow the European and American coasts southward. It is scarcely found north of the ridge across the Denmark Strait or that between Iceland and the Faröe Islands. It seems absolutely to demand a positive bottom temperature.

6. **Calveria hystrix** [1]) Wyv. Thomson.

Pl. III. Figs. 1—2. Pl. XI. Figs. 5, 29. Pl. XII. Fig. 34. Pl. XIII. Figs. 17, 18. Pl. XIV. Figs. 13, 26.

Synonym: *Asthenosoma hystrix* (Agassiz, Bell, Koehler etc.).

Non: *Calveria* (*Asthenosoma*) *fenestrata* Wyv. Thomson.

Principal literature: Wyv. Thomson: Echinoidea of Porcupine» (395) p. 738. Pl. LXIV—LXV. — A. Agassiz: Revision of Echini II. p. 273. Pl. II. c. Fig. 1—5 (?). — 6 p. 74. — 14 p. 3. Pl. II. Fig. 1—2. — W. E. Hoyle: Revised List of Brit. Echinoidea. (202) p. 407. — F. Jeffr. Bell: 72 p. 526. Pl. XXIV—XXV. — Catalogue of British Echinoderms. p. 143. — R. Koehler: 229 p. 9.

After the excellent description of this species by Wyv. Thomson it is unnecessary here to give a new thorough description of it; only a few points stand in need of a somewhat more exact description than has hitherto been given.

The primary spines on the actinal side are curved (somewhat more than shown by the figure (Pl. III. Fig. 2)), and end in a small, short, and somewhat widened hoof; it is whitish, and consequently rather conspicuous on the pink spine. «Flaring at the extremity», Agassiz (14 p. 5) says of the spines, otherwise their ending in a hoof is not mentioned in the literature. In transverse sections of the spines (Pl. XI. Fig. 5) it is seen that the longitudinal ridges are rather low, widened in the outer part, with a little projection (indented) on the outside. The small spines on the abactinal side give in transverse sections a figure a little different (Pl. XI. Fig. 5 b); the outer surface of the longitudinal ridges is finely arcuate, and their edges are almost joining.

The pedicellariæ have been excellently described and figured by Wyv. Thomson, who gives, however, no figures of the single valves, so that the features systematically most important cannot be seen in his figures. In the larger form of tridentate pedicellariæ (Pl. XIV. Fig. 26) the blade is highly

[1]) On Pl. III it is wrongly called *Asthenosoma*; this plate was reproduced before my stay at British Museum, that is to say, before I had a quite clear understanding of the generic relations of the Echinothurids.

involuted, only the point is somewhat widened, and the edge of this terminal part is almost straight cut off, but irregularly serrate. The involuted part of the blade is filled by an irregular net of meshes. In the smaller form of tridentate pedicellariæ (Pl. XIII. Figs. 17—18) there is a comparatively larger widened part in the point of the blade, and a corresponding smaller, involuted part; this feature is rather varying according to the size. The edge of the widened part is also here irregularly serrate, but may in the smallest specimens be almost quite straight and regularly serrate. The blade is less curved in the small form than in the large one, and accordingly the valves are less wide apart when the pedicellaria is shut, which feature is excellently seen in the figures of Wyv. Thomson. I quite agree with Wyv. Thomson, when he thinks this smaller form to be «a modification of the first more or less reduced in size and lengthened in its proportions»; on the other hand I must protest against his finding it «like some of the common varieties in the Cidaridæ» (op. cit. p. 739). Any resemblance to the pedicellariæ of the Cidarids is absolutely not found, except so far that both forms are pedicellariæ, and as such agree in their chief structures. — The size of the tridentate pedicellariæ (the head) is up to 1·2^{mm}, as stated by Wyv. Thomson. The neck is rather short in the large pedicellariæ, somewhat more developed in the small ones. The triphyllous pedicellariæ have a very large cover-plate, most frequently almost without holes; only in the median line there is a series of large holes, made by protuberances from the sides of the cover-plate growing towards the middle and coalescing there (Pl. XII. Fig. 34). The outer edge is rather strongly dentate. The stalk of the pedicellariæ is of the structure common in the Echinothurids, irregularly perforated. The sphæridiæ are rather long-stalked, their head beautifully round and smooth (Pl. XIV. Fig. 13).

The spicules are arranged in two series in the lower part of the tube feet; they are here narrow, more or less rod-shaped, with few, sometimes no holes (Pl. XI. Fig. 29); they are placed across the longitudinal axis of the foot. Above they are large, irregular fenestrated plates quite encompassing the foot.

The «longitudinal muscles» are well developed; on the other hand no distinct organs of Stewart were seen in the specimen I opened. To be sure, Koehler (op. cit.) states the organs of Stewart to be well developed. As Koehler, however, follows Bell in regarding *Calveria hystrix* and *fenestrata* as synonyms, it cannot be seen, which of these species he has examined. Nor could I see the organs of Stewart in a specimen of the latter species.

Of *Calveria hystrix* two specimens have been obtained by the «Ingolf»-Expedition on the stations 89 (64° 45′ N. Lat., 27° 20′ W. L. 310 fathoms, the bottom mud, bottom temperature 8°), and 97 (65° 28′ N. Lat., 27° 39′ W. L. 450 fathoms. Sandy mud. Bottom temperature 5° 1). The specimen from st. 97 is very beautifully preserved, and as the colour has almost not faded — to judge by a coloured sketch made on board from the living animal — it is here figured in colours (Pl. III. Figs. 1—2); only the darker bands mentioned by Wyv. Thomson (p. 740), are no longer seen distinctly; in the original sketch they are indicated.

Whether the specimen of 3^{mm} mentioned by Agassiz in Rev. of Echini, Pt. II. p. 273, really is a *C. hystrix*, cannot be seen from the figures. Agassiz, to be sure, says that «the pedicellariæ are similar»; but it is not quite evident whether they resemble those of *C. hystrix*, or those of *Asthenosoma Grubei*; and even if the meaning be that they resemble the figures of the pedicellariæ in *C. hystrix*

given by Wyv. Thomson, the statement is not to be relied on, as the most characteristic feature of these, the irregular edge of the terminal part of the blade, has not before been observed.

The statements in the literature with regard to the distribution of this species, are upon the whole quite unreliable, as we cannot be sure that it is really this species which has been examined in each case. No doubt the statements apply often to *Aræosoma fenestratum*, and probably also to *A. Belli* Mrtsn. (see above p. 54—55), which has likewise been confounded with *C. hystrix*. It may, however, be taken to be probable that its distribution is the same as that of *Phormosoma placenta*, viz. ca. 100—ca. 1000 fathoms along the coasts of Europe and North America, and across the Atlantic south of Iceland. It is only known from the territory with positive bottom temperature. In the «cold area» it is certainly not found.

7. **Aræosoma fenestratum** (Wyv. Thomson).

Pl. XI. Fig. 8. Pl. XII. Fig. 33. Pl. XIV. Figs. 1, 8, 14, 17, 18, 24, 32.

Synonyms: *Calveria fenestrata* Wyv. Thomson.
Asthenosoma fenestratum (A. Agass.).
— *Reynoldsii* A. Agass.

Non: *Calveria* (*Asthenosoma*) *hystrix* Wyv. Thomson.

Principal literature: Wyv. Thomson: Echinoidea of «Porcupine» (395) p. 741. Pl. LXIII. 9—10, LXVI—LXVII. — A. Agassiz: 6. p. 75. «Blake»-Echini (9) p. 29. Pl. XIII—XIV. («*Asthenosoma hystrix*»). — W. E. Hoyle: Rev. List of Brit. Echinoidea (202). p. 408. — F. Jeffr. Bell: 72. Pl. XXIV. Fig. 1, Pl. XXV.

The reasons why this species is not, as has been supposed by Bell (72) and Koehler (229), synonymous with *Calveria hystrix*, but on the contrary must be referred to another genus, have been given above (p. 52—53). — In «Preliminary Report of the Blake»-Echini» (6. p. 75) Agassiz describes an *Asthenosoma* by the name of *A. Reynoldsii*, «readily distinguished from *A. hystrix* by the larger, higher coronal plates, the prominent vertical row of primary tubercles on the outer edge of the interambulacral area on the abactinal side, the less numerous secondaries and miliaries and the color of the test. The primary spines, quite closely packed, on the actinal side, are long, slender, slightly curved, and trumpet shaped; on the abactinal side they form one principal vertical row extending half-way to the apical system near the outer edge of the interambulacral areas. The rest of the test is covered by distant small secondary spines». After having examined a great many specimens, Agassiz has later (9. p. 29) got the conviction that the specimens he separated as *A. Reynoldsii*, «are only large specimens of *Asthenosoma hystrix*; the differences, striking as they appear, are merely due to age».

From the «Ingolf» (st. 89) we have a specimen, no doubt identical with the «*A. Reynoldsii*» of Agassiz; it agrees very well with the description quoted, and with a specimen received from U. S. National Museum under the name of «*Asthenosoma hystrix*», and both agree exactly with a fragment of a type specimen of *Calveria fenestrata* which I had occasion to examine in British Museum (see above p. 53). It is true that the tetradactylous pedicellariæ are wanting in both specimens as well as in the mentioned type specimen; but in all other respects they are quite similar, and above all, the tridentate pedicellariæ are identical in all of them. There can be no doubt that the long missed, at

last almost mystical *Calveria fenestrata* has here been refound. It proves, into the bargain, to be common enough, and has only been missed, because it has been confounded with *Calveria hystrix*. The exceedingly remarkable tetradactylous pedicellariæ, which would be an excellent character of this species, seem generally to be wanting, probably broken off, possibly originally wanting in some specimens (as in other Echinids individuals are often found quite wanting some kind of pedicellariæ normally found in the species, — for instance globiferous pedicellariæ in *Echinus Alexandri*). To be sure, the difference between the two species with regard to their habitus is considerable; but if we examine more exactly the details of this difference, we shall be much surprised to find a great conformity in almost all external features, above all in the arrangement of the tubercles. No other difference can in reality be given with regard to the common appearance than the fact that *A. fenestratum* is far more robust than *Calveria hystrix*, and that the colour is different. The great difference in the form of the plates in the two species emphasized by Wyv. Thomson as a chief character, is only to be seen in dried specimens, and, strictly speaking, only from the inside; it is moreover, as shown by Bell (op. cit.), subject to great variation. It is only by examining the pedicellariæ that we find sure characters. As the pedicellariæ have not hitherto been taken into consideration, there is, so far, a good excuse of the fault committed by the confounding of the two species.

A thorough description of this species is not necessary here, any more than with regard to the two preceding ones; I shall only make some supplementary remarks, and for the rest the reader is referred to the descriptions by Wyv. Thomson and Agassiz (the latter one to be found under *A. Reynoldsii*).

The primary spines of the actinal side end in a small, short, and rather broad hoof; this I take to be what Agassiz means by calling them »trumpet-shaped». The structure is as in *Calveria hystrix*, only that the spines seem here always to be smooth, while in *C. hystrix* they are more or less thorny. (Transverse section. Pl. XI. Fig. 8). The spicules are large, irregular fenestrated plates, which in the outer part of the tube foot encompass it completely; in the lower part they are somewhat smaller, and are arranged in four longitudinal series. Sucking disk well developed.

The tetradactylous pedicellariæ I have not seen, but as in *A. coriaceum* they are quite similar to those figured by Wyv. Thomson for *A. fenestratum*, it may be considered rather certain that no specific characters are found in them. Such characters are, on the contrary, found in the tridentate pedicellariæ, as shown above. There are two forms of tridentate pedicellariæ. In the larger form, which has been overlooked by Wyv. Thomson, but which I have found in the mentioned type specimen, the blade is much involuted and curved outward. The point is somewhat widened, and has two deep sinuations in the edge on each side (Pl. XIV. Fig. 32), but the edge is otherwise not indented. The blade is filled by a rather coarse net of meshes. The valves are very wide apart when the pedicellaria is shut. The base is especially large, so that there is room for a great many muscular fibres; no doubt these pedicellariæ are very powerful. The head has a length of up to 2^{mm}, the neck is quite short. — The smaller form is very much varying as to size and form; the larger ones (Pl. XIV. Fig. 24) recall the large form very much, but the valves are much less curved, the widened part of the point is comparatively larger, and the edge not so deeply sinuate. In the smallest ones the valves are almost not separated, and the edge is almost quite straight. Wyv. Thomson has figured one of

these smaller forms (Pl. LXVII. Fig. 7). On Pl. XIV. Figs. 8, 17, 18, 24 valves of larger and smaller specimens of this form have been figured; they are all extremely finely serrate in the edge. They are short-necked as the large form, the smallest ones, however, with a somewhat longer neck. The stalk of the common structure. The cover-plate of the triphyllous pedicellariæ is highly developed (on Pl. XII. Fig. 33 there is a broad, open space in the median line, but most frequently the projections of the edges join in the middle, so that the common series of large holes in the median line is formed); the valves are lengthened, narrow below, rather abruptly widened above. The edge finely serrate. — The sphæridiæ (Pl. XIV. Fig. 14) are somewhat more lengthened than in *C. hystrix*.

Wyv. Thomson (op. cit. p. 473) describes the colour of this species very thoroughly. Bell (72. Pl. XXIV) gives a couple of excellent coloured figures of the two species *hystrix* and *fenestratum* (only the test). As already mentioned he regards them as one species, as he finds very great variation in the size of the uncalcified space between the plates. With regard to the different colouring Bell remarks: «The coloration of tests, however, does not often go far in helping in the discrimination of species of Echinoids». He finds a considerable variation in the extent and intensity of the colour, and some specimens are, moreover, quite bleached. — I am inclined to attach more importance to the colour as a distinguishing mark between the Echinids. To be sure, bleached specimens are often met with, and they, of course, cannot be recognised by the colour, but fortunately specimens are very often found that have kept their natural colour almost completely, and such specimens are found, at all events, in most of the divisions of Echinids. In such specimens the colour is a really good character, as, according to my observations (and I have seen numbers of living Echinids, as well in northern as in tropic seas) the species have most frequently a rather constant and characteristic coloration. However, I think the colour to be only rarely an absolutely reliable character. As to the two figures given by Bell there is, in my opinion, no doubt that Fig. 1 is *A. fenestratum* and Fig. 2 *Calveria hystrix*.

The longitudinal muscles are well developed; I have not been able to find organs of Stewart in the specimen I have opened.

Only one specimen has been taken by the «Ingolf», st. 89 (64° 45′ N. Lat. 27° 20′ W. L. 310 fathoms. Bottom temperature 8°), the Denmark Strait.

With regard to the distribution of this species we have only few sure facts. The «Porcupine»-Expedition took it off the Portuguese coast; that it is also found off the western coast of Ireland appears with certainty from the paper by Bell (72) quoted above. Agassiz enumerates several localities from the sea round Barbados for *A. Reynoldsii*, and in British Museum I have myself seen a specimen (called *A. hystrix*) from Barbados, which is no doubt *A. fenestratum*. Our museum has further received a specimen from Smithsonian Institution obtained near Florida (32° 36′ N. Lat. 77° 29′ 15″ W. L. 258 fathoms); it is also called *A. hystrix*, but is *A. fenestratum*. From these statements it may be concluded with rather great certainty that like *Ph. placenta* and *C. hystrix* it is found in the whole northern Atlantic, as well on the American as on the European side, and across the Atlantic south of Iceland on the slopes towards the deep. Its vertical distribution seems to be somewhat smaller than that of the other species, the greatest depth from which it is mentioned, being 373 fathoms (*A. Reynoldsii*, Agassiz, 6); the smallest depth on which it has been taken, is 81 fathoms

(Hoyle, op. cit.). Thus it seems to belong more to the sublittoral fauna than to the archibenthal one. It is certainly only found in places with positive bottom temperature. North of the ridge in the Denmark Strait and the one between Iceland and the Faröe Islands it is scarcely found — still less in the deep regions North of Iceland.

8. **Sperosoma Grimaldii** Koehler.

Pl. IV. Figs. 3—5. Pl. XI. Fig. 9. Pl. XII. Fig. 16. Pl. XIII. Figs. 12, 23. Pl. XIV. Figs. 2, 4, 4 a, 6, 11, 31, 33.

Literature: R. Koehler: 228. 229, p. 16. Pl. II, III etc.

Of this species we have two fine specimens from the Ingolf-Expedition, st. 83 (62° 25′ N. Lat. 28° 30′ W. L. 912 fathoms. Bottom temperature 3°. The ridge south west of Iceland), a large one of a diameter of 150mm, and a small one of a diameter of 27mm. The large specimen is much bleached, and shows the violet colour only in spots — it has already been observed by Koehler that this species has a tendency to lose the colour in alcohol; — the small specimen has kept the colour very beautifully.

The large specimen agrees, with regard to the actinal side, exactly with the description by Koehler; the abactinal side, on the other hand, shows some deviations, so that I felt a doubt whether it might not possibly be another species than the specimens Koehler has had. So I sent the original drawing of Pl. IV. Fig. 3 to Prof. Koehler, and asked him to give me his opinion with regard to this fact, calling his attention to the deviations from his description, found in this specimen. He has then informed me that in spite of the difference in the form of the plates and the arrangement of the pores on the abactinal side he thinks it to be the same species, and trusting to his authority I refer this beautiful specimen to *Sp. Grimaldii.*

The ambulacral areas (of the abactinal side) are not narrower than the interambulacral ones, but even a little broader. Just above the ambitus the middle part of the ambulacral area is only formed by the primary plates, the inner accessory ambulacral plate is quite small, placed about at the middle of the primary plate; the outer one is large reaching quite to the edge of the area, and often expanding so much, that the primary plate does not reach to the edge. A little way, ca. 5—6 plates, above the ambitus, the inner accessory ambulacral plate increases rather abruptly so much in size, that it reaches quite to the median line of the area, and so it continues quite to the apical area. Thus the primary ambulacral plates are here separated for their whole length; they are of almost the same height from the median line of the area to its edge, and so the whole area looks rather regular[1]). — The tube foot belonging to the inner accessory ambulacral plate, is well developed, that of the outer accessory plate and of the primary one is quite rudimentary. The two tube feet of the accessory plates are placed quite near each other, just at the boundary line between the plates, and in about the same height; that of the primary plate is placed opposite to the interspace between the two others. The form of the interambulacral plates is also somewhat different from that in the figure of Koehler; they are distinctly bent in an angular manner, with the point turned towards the apical area.

The plates of the apical area cannot be seen through the skin, only the madreporite; the

1) The figure (Pl. IV. Fig. 3) does not render all these details of the structure of the ambulacral areas quite clear nor quite exactly, but on the other hand it renders the habitus of the animal quite excellently.

latter is very large and broad, and the pores spread also over some of the small plates inside of it. Koehler says that the madreporite is triangular, very large, and prolonged; his figure does not show this, there it is scarcely larger than the other genital plates. — The genital openings are covered by a large genital papilla, 3—4^{mm} long, resembling a tube foot. Prof. Koehler informs me that a similar formation was found in his specimens; he has seen traces of it on some of the plates; but as his specimens were badly preserved he could not distinguish the nature of these traces with certainty, but took them to be loosened pieces of skin. After having seen my drawing he feels certain that they were the genital papillæ. — A similar formation is mentioned by de Loriol (246 p. 369) in the specimen he (wrongly) takes to be a young *Asthenosoma varium*: «les pores génitaux sont très grands, circulaires, couverts d'une fine membrane au milieu de laquelle saillit la papille génitale»; for the rest de Loriol has no further remarks of this peculiar formation.

Neither with regard to the spines of the dorsal side does this specimen quite agree with the description of Koehler: «Dans les zones interambulacraires les tubercules primaires forment, vers le milieu de chaque rangée de plaques, une file assez regulière qui s'étend jusqu'à une petite distance du périprocte, mais toutes les plaques interambulacraires ne portent pas de ces tubercules primaires» (p. 19). Here they do not at all form a regular series, are on the contrary placed very irregularly. According to Koehler the spines are much shorter on the abactinal side than on the actinal side; in the specimen in hand the fact seems not to have been so. To be sure all the primary spines on the abactinal side are broken, but to judge from the fragments kept, they must have been of about the same length as the primary spines on the actinal side. As observed by Koehler, the abactinal side looks rather naked here being far fewer spines than on the actinal side. — The structure of the spines is the common beautiful one: regularly perforated tubes with raised longitudinal ridges, ending in a fine point. Transverse sections of the large primary spines from the actinal side (Pl. XI. Fig. 9a) show the longitudinal ridges highly developed, with the outer surface widened, so that their edges join completely; they are much hollowed along the median line; secondary connecting beams between the longitudinal ridges may be more or less developed. The small spines on the abactinal side are also provided with strong longitudinal ridges, with widened outer surface, and hollowed along the median line (Pl. XI. Fig. 9b). The primary spines on the actinal side as also the spines of the peristome are somewhat thorny, the abactinal ones are quite smooth.

Koehler gives a figure of a whole tridentate pedicellaria, but he gives no informations of the structure of the blade except the one thing that the edge is not serrate — and this is scarcely correct, at all events it does not apply to the specimen in hand. In the largest pedicellariæ (the head of a length of up to 2^{mm}) the valves are very broad and flat, and join completely, when the pedicellaria is closed (Pl. XIV. Fig. 33). The widenings from the upper end of the apophysis reach almost or quite to the edge of the blade, which is not involuted; in the outer part of the blade the edge is somewhat sinuate. The blade is filled by a very complicated net of meshes continuing into strong spines, arranged tolerably in longitudinal series (Pl. XIII. Fig. 12). In smaller pedicellariæ the net of meshes is more slightly developed, and only quite few teeth or none at all are found (Pl. XIV. Figs. 2, 6). The quite small ones have only an indication of a net of meshes above the apophysis, and their blade is much narrower. As all transitions are found between these forms, no distinction can be made

between two kinds of tridentate pedicellariæ. The neck is rather short, the stalk of the common structure (Pl. XIV. Fig. 31). The cover-plate of the triphyllous pedicellariæ is rather well developed, with numerous small holes; the outer part of the blade is not very broad, the edge finely serrate (Pl. XII. Fig. 16).

The spicules of the tube feet on the actinal side are large, generally somewhat curved fenestrated plates (Pl. XIV. Fig. 4 a); they inclose the foot completely and are not distinctly arranged in longitudinal series. A little sucking disk is found with a rather irregular calcareous rosette (Pl. XIV. Fig. 4). Just below the sucking disk the spicules stick, so that this part of the tube foot cannot be contracted, whereas the other part is highly contractible, as is commonly the case in the Echinids; the point with the sucking disk is then seen to be sharply marked off from the other, much thicker part of the tube foot. In the contracted part the spicules are arranged in such a way as to form an imbrication. The tube feet of the abactinal side have, as usual, no sucking disk, and the spicules are small, irregular, branched calcareous bodies (Pl. XIV. Fig. 4 a), arranged in 2—3 longitudinal series.

The sphæridiæ are as usual placed along the tube feet quite up on the abactinal side, where they are situated at the large tube foot, 1—3 sphæridiæ at each foot. They are rather lengthened (Pl. XIV. Fig. 11).

Together with this specimen a beautiful, small one has been taken, as mentioned above, of a diameter of 27^{mm}, which I suppose will have to be referred to the same species, although it differs somewhat from the large specimen with regard to the structure of the test (Pl. IV. Figs. 4, 5). The ambulacral areas are somewhat narrower than the interambulacral ones, also on the actinal side. The tube feet are placed in three series, but not very far from each other; they are arranged in arcs of three as in an *Echinus*, which is especially distinctly seen on the abactinal side. The small ambulacral plates are not distinct, the primary ones are especially regular and straight; this applies also to the interambulacral plates, which are, accordingly, not yet angularly bent as in the adult. The primary spines and tubercles form rather regular series in both areas; in the ambulacral areas there are on the actinal side a couple of especially large ones near the ambitus, much larger than the adjoining ones; in some plates spines are quite wanting. In the interambulacral areas they form a more regular series on either side gradually increasing in size towards the ambitus; primary tubercles are found in all the plates, and some have, besides, a few secondary tubercles. On the abactinal side the series of tubercles are very regular in the ambulacral areas where the size is about the same till towards the apical area. The tubercles of the interambulacral areas are more unequal, some being quite small, others very large. The spines, unfortunately, are all broken. The apical area is large, the madreporite rather distinct. No genital papillæ are as yet developed, nor are the pores as yet formed. The pedicellariæ are as in the large specimen, but as yet no large tridentate pedicellariæ with the blade filled by a thorny net of meshes are found. Of the tube feet on the abactinal side only the innermost one of each arc is well developed, the two others are rudimentary as in the large specimen. The spicules of the tube feet of the actinal side are as those of the large specimen, only somewhat smaller and distinctly arranged in series. The sucking disk only slightly developed. In the abactinal tube feet the spicules have only just begun to appear.

Sperosoma Grimaldii was hitherto only known from the Azores, from c. 600—930 fathoms. As

it is now also known from the sea south of Iceland, it is to be supposed that its distribution will prove to agree with that of the three other Echinothurids mentioned in the preceding, so that it belongs to the rich fauna found on the large slopes towards the deep of the Atlantic.

9. **Tromikosoma Koehleri** n. g., n. sp.

Pl. XI Figs. 2, 13. Pl. XII. Figs. 22, 31, 41. Pl. XIV. Figs. 12, 16, 19, 21, 23, 25, 28, 30.

Of this species we have only one very large specimen, 180mm in diameter, from st. 36 (61° 50′ N. Lat. 56° 21′ W. L. 1435 fathoms, bottom temperature 2°), the Davis Strait. Unfortunately it is very badly preserved, so that the description cannot be complete, and no figure can be given of the whole animal. So many characters may, however, be distinguished in the animal before us, that genus and species can be recognised with certainty. — With regard to the generic characters see above p. 64—65.

The structure of the test cannot be described completely, as the whole actinal side is torn; the abactinal side, on the other hand, is whole, and permits an examination of the form of the plates (Figs. 5—6). The ambulacral areas (Fig. 5) are uncommonly broad, a little broader than the interambulacral areas. The primary ambulacral plates are angularly bent, with their top turned towards the ambitus; the outer half is a litte narrower than the inner one. The secondary ambulacral plates are particularly well developed, especially the outer one which reaches quite to the edge of the ambulacral area. Near the apical area the inner accessory ambulacral plate reaches quite to the median line where it adjoins the point of the primary ambulacral plate from the opposite side. Thus the primary ambulacral plates of the same side are here quite separated. The pores of the accessory plates are situated near the boundary line between the plates, the pore of the primary ambulacral plate is placed about under that of the inner accessory plate. Also the interambulacral plates are angularly bent, but in a direction contrary to that of the ambulacral plates (Fig. 6).

Fig. 5.

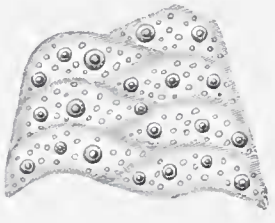

Fig. 6.

Piece of ambulacral and interambulacral area of *Tromikosoma Koehleri* (1/1). In the animal the boundaries between the plates are white, the plates of a bluish gray.

The primary spines are placed rather scattered and irregularly. On the actinal side, near the ambitus, 3—5 large spines are found, ending in a large, white hoof (Pl. XIV. Fig. 30); (this, I suppose, applies to all of them, but they were all broken, and the hoofs torn off were at the bottom of the glass in which the animal was kept.) They are not placed in regular series, in the ambulacral areas only one is found in each plate, in the interambulacral areas two in each plate. The areoles are rather large, but widely separated, forming no horizontal series. The whole actinal side is otherwise rather closely set with fine secondary spines. The peristome is closely set with shorter, somewhat club-shaped, in the lower part skin-covered spines, which are — at all events some of them — provided with a little hoof in the point narrower than the spine (Pl. XIV. Fig. 28). The hoof, as is commonly the case, is of another structure than the spine, being smooth, compact, while the spine (at all events in the lower part) is tubiform, and provided with thorny ridges; the hoof is very distinctly limited, so that it looks like a little joint on the end of the spine. (Also the hoof of the large spines is sharply limited from the other part of

the spine (Pl. XIV. Fig. 30), being placed like a cap on the point.) — It cannot be decided, whether the spines of the peristome are placed in concentric circles, but I think it probable. On the abactinal side the rather numerous primary spines are irregularly scattered over the whole surface, not arranged in series (Figs. 5—6). A great many miliary tubercles carrying small spines or pedicellariæ, are scattered over as well the ambulacral as the interambulacral plates.

The structure of the spines is as usual. The small ones are regular, perforated tubes ending in a fine point; no thorns seem to be found on them. The large spines with the hoofs are constructed in a more complicated manner. The longitudinal ridges are very prominent, narrow, widened in the outer end, and a little hollow on the outside; in transverse sections they are T-shaped. Between these ridges connecting beams are often developed, so that a rather complicated reticulation is formed; towards the central hollow the boundary is regular. The small abactinal spines have little conspicuous longitudinal ridges, not widened along the outer surface (Pl. XI. Fig. 2, a—c).

The apical area resembles that of *Hygrosoma luculentum*, which has been figured by Agassiz (Chall. Ech. Pl. X. a. Fig. 3); but the form of the plates is otherwise only seen with difficulty.

The tube feet are placed in one irregular series on the actinal side; on the abactinal side they are placed alternally two opposite each other, and one single, as is shown by the pores in Fig. 5; most frequently the inner one of the two placed at the same height (the one in the inner accessory ambulacral plate) is somewhat larger than the others. The spicules are irregular, net-shaped plates; they may be exceedingly complicated, and are not arranged in longitudinal series, but inclose the whole foot. They are placed in 2—3 layers; in the tube feet of the abactinal side the inmost layer consists of larger, perforated plates, the outermost one of irregularly branched spicules (Pl. XI. Fig. 13), in the tube feet of the actinal side the whole thing forms a complete confusion of net-shaped plates. No sucking disk is developed.

The sphæridiæ (Pl. XIV. Fig. 12) are of the common form, and, as is commonly the case in the Echinothurids, are placed along the series of tube feet quite up on the abactinal side.

The pedicellariæ: The tridentate pedicellariæ occur in two different forms, not, however, sharply distinguished. In the larger form (Pl. XII. Fig. 41, Pl. XIV. Fig. 21), the head of which reaches a length of up to 3·5^{mm}, the blade is filled by a very complicated net of meshes rising into strong thorns, partly arranged in series; it is somewhat widened in the point, more narrow in the middle, but the edges, which are here coarsely serrate, are not involuted. The valves are rather wide apart, when the pedicellaria is shut. The neck is very short, the stalk of the common structure. In the smaller form the blade is almost of the same breadth throughout its whole length, not widened in the point; it resembles very much the form found in *Phormosoma placenta* — which is, no doubt, as well the most frequent as the simplest form of tridentate pedicellariæ in the Echinothurids — but the widenings of the upper end of the apophysis reach quite to the edge of the blade, they do not end down on the side as in *Ph. placenta*. In the bottom of the blade there is a not very much developed reticulation, in the smallest ones almost none is found (Pl. XII. Fig. 22), in the larger (Pl. XIV. Fig. 16) it is more developed, in the largest ones even with a short, prominent, serrate crest, thus forming a transition to the large form. In the small ones the valves join completely, when the pedicellaria is shut; the edge is finely serrate; the neck is rather long, the stalk of the common structure.

In the triphyllous pedicellariæ the cover-plate is rather little developed; the outer edge is finely serrate (Pl. XII. Fig. 31); upon the whole they show no great difference from the common form. On the other hand the ophicephalous pedicellariæ are very peculiar (Pl. XIV. Figs. 19, 23, 25). The valves are highly constricted in the middle, the outer part widens suddenly to the same breadth as below, so that the blade is somewhat widened in a wing-shaped manner. The edge is thick and strongly serrate; the middle part of the blade is deep and perforated, the wing-shaped widenings flat, without holes. The arcs below the articular surface peculiar of the ophicephalous pedicellariæ, are well developed. The neck is short — contrary to the ophicephalous pedicellariæ of the Echinids — and it seems to contain only longitudinal muscles. The stalk is quite different from that of the other pedicellariæ: a wide tube with rather few, small holes, somewhat widened above, but not below, only are the holes here placed more close together than in the other part of the stalk. The length of the head is ca. $0{\cdot}5^{mm}$, that of the stalk ca. 3^{mm}. They are only (?) found on the abactinal side.

The colour is gray with a slight indication of violet; in the living animal the colour was about the same as in the preserved one. The spines white.

Besides the species here described, at least one more species of the family of Echinothurids is found in the northern Atlantic; Agassiz in «Blake»-Echini (9) p. 35 mentions a specimen of «*Phormosoma uranus*» from the Faröe Channel; and on the basis of this statement Bell (73) and Hoyle (202) mention *Phormosoma uranus* among the Echinids occurring in the British seas. Also Sladen (367. p. 701) mentions *Ph. uranus* from the south west coast of Ireland, as he finds a specimen before him agreeing with the figures and descriptions of Wyv. Thomson and Agassiz. According to what has been stated above (p. 58) with regard to «*Phormosoma uranus*», it is impossible to know with certainty, whether the specimens that Agassiz and Sladen have had, have really been «*Phormosoma* (*Echinosoma*) *uranus*» and not *Hygrosoma Petersii*. As no specimen of these two species has been obtained by the «Ingolf»-Expedition, I shall give no thorough description of them, but only refer to what has been said above of these species. Otherwise it may be taken to be probable that both these species and also the *Arœosoma Belli* hitherto only known from Barbados, are found in the northern Atlantic on the slopes towards the deep, and belong to the wonderfully rich archibenthal fauna, peculiar to the smaller depths along the European and American coasts and across the Atlantic, south of Iceland. The three mentioned species are therefore included in the following table of the North-atlantic Echinothurids.

Table of the Echinothurids occurring in the Northern Atlantic.

1. The primary spines on the actinal side straight, inclosed by a thick bag of skin; great difference between the actinal and abactinal sides. The tube feet on the actinal side in one series. Only tridentate and triphyllous pedicellariæ, the former simply leaf-shaped.....	*Phormosoma placenta* Wyv. Thomson.
The primary spines on the actinal side curved, ending in a larger or smaller hoof.....	2.

2. The tube feet on the actinal side in a single, almost regular series; the test very soft ..... 3.

   The tube feet on the actinal side in three more or less separated series ..... 5.

3. Ophicephalous pedicellariæ are found ..... *Tromikosoma Kochleri* Mrtsn.

   Only tridentate and triphyllous pedicellariæ ..... 4.

4. The tridentate pedicellariæ simply leaf-shaped ..... *Echinosoma uranus* (Wyv. Thomson).

   The tridentate pedicellariæ with much involuted blade, the point widened in a spoon-like manner with straight, finely serrate edge ..... *Hygrosoma Petersii* (A. Agass.).

5. The three series of tube feet rather close together; the ambulacral areas of the common structure; the tridentate pedicellariæ not simply leaf-shaped. The hoof small ..... 6.

   The three series of tube feet widely separated; the ambulacral areas on the actinal side formed by 8 series of plates. Tridentate pedicellariæ simply leaf-shaped, the largest ones with a rich, thorny net of meshes filling the blade. The hoof large ..... *Sperosoma Grimaldii* Koehler.

6. The large tridentate pedicellariæ with much involuted edge; the widened part of the point finely, but irregularly serrate in the edge; the smaller tridentate pedicellariæ of a similar structure ..... *Calveria hystrix* Wyv. Thomson.

   The large tridentate pedicellariæ with much involuted edge; the widened part of the point is deeply and coarsely indented in the edge. Tetradactylous pedicellariæ may be found ..... 7.

7. The smaller pedicellariæ with the widened part of the point coarsely sinuate in the edge ..... *Aræosoma fenestratum* Wyv. Thomson.

   The smaller pedicellariæ with the widened part of the point of the blade straight and finely serrate in the edge. Moreover a very large form is found with coarsely indented edge ..... *Aræosoma Belli* Mrtsn.

Fam. Temnopleuridæ.

Hypsiechinus n. g.

The test generally without distinct grooves or furrows; no distinct slits in the edge of the mouth. The buccal membrane covered with large plates; all the buccal tube feet are generally well developed in the adult individuals. None of the ocular plates reaches quite to the periproct, which is

covered by one large plate and several small ones. The pores are trigeminate, but placed in an almost straight line; only in the lower part of the areas they are distinctly seen to be trigeminate. The spines are rather highly thorny, those nearest to the peristome curved. The globiferous pedicellariæ without any neck; the blade with simple edges, not connected by cross-beams; 2—3 teeth on either side. The spicules irregular, three-radiate. The auriculæ are formed as two narrow crests, not joining above.

This little Echinid recalls to some degree *Prionechinus* A. Ag., and together with the latter genus and the genera *Trigonocidaris*, *Temnechinus*, and *Cottaldia* it may be taken to form a special group of the Temnopleurids. I shall not, however, here enter into a nearer examination of the classification of the Temnopleurids, as I have not yet studied this question sufficiently, but shall only make some observations with regard to the mentioned genera, which I have had occasion to examine. Especially *Prionechinus* and *Cottaldia* stand in need of a more thorough description than has hitherto been given, and I have in British Museum seen the type specimens of both of these genera.

Prionechinus sagittiger A. Ag. According to Agassiz only badly preserved specimens of this species are found in the collections from «Challenger». I have, however, seen a very well preserved specimen from st. 218, and the figure (Chall. Ech. Pl. VI. a. Fig. 11) of the whole animal given by Agassiz is, I suppose, taken just from this specimen. Further I have seen a specimen from st. 207, determined as *Prionechinus sagittiger*; it is, no doubt, a quite different genus. The specimen from st. 218, which corresponds to the habitus figure of this species given by Agassiz, must then be considered as the type of it.

«There is but a single row of plates of pores of equal size in the ambulacral zone», it is said in the description (Chall. Ech. p. 109). I do not understand the meaning of this sentence; according to my observations the ambulacral areas show no unusual structures. — It is further said in the description that «the pairs of large pores are arranged in a single vertical row», and according to Pl. VI. a. Fig. 14 there are only two pairs of pores for each ambulacral plate. This does not at all hold good with regard to *Prionechinus*; first this figure is no doubt drawn from the specimen from st. 207, in which the pores are really very large and form a straight line, and secondly the figure is incorrect — also in this specimen 3 pairs of pores are found for each ambulacral plate. In the real *Prionechinus* the pores are very small, and only one pore for each tube foot is seen distinctly. There are as usual three pairs of pores for each ambulacral plate. — «In all the buccal plates the tentacle of one of the pairs is rudimentary or even wanting». The meaning of this indistinct sentence is that in each pair of buccal tentacles one is rudimentary or wanting; it is seen on the Fig. 12 of Agassiz — and in the specimen from st. 207. Perhaps this fact also applies to *Prionechinus*; it is now and then found in *Hypsicchinus*, so that the feature is not at all unique. The peculiar spines resemble those of *Hypsicchinus*, but they are not curved. The spicules are bihamate, but very few, in most of the tube feet none are found. The sucking disk is typically developed. — «The pedicellariæ are numerous —; they are all of the large-headed slender-stemmed form»; Agassiz gives no more informations of the pedicellariæ, and no figures are given. The four usual kinds of pedicellariæ are found. The globiferous ones (Pl. VII. Fig. 29) have only one, unpaired lateral tooth on the blade, the edges of which are thick, not connected by cross-beams. The poison glands are very small, not reaching to the basal part of

the valve. The tridentate pedicellariæ have rather strong teeth in the point of the blade (Pl. VII. Fig. 21); along the median line of the blade the holes are large, lengthened; no net of meshes in the bottom. Only the points of the valves join when the pedicellaria is shut; below they are wide apart. The neck rather long. The ophicephalous pedicellariæ are of the common structure resembling those of *Hypsicchinus*; they are short-necked. The triphyllous pedicellariæ are very small, with finely serrate edge (Pl. VII. Fig. 25). The stalk of the pedicellariæ consists of longitudinal fibres connected by cross-beams to a compact reticulation, as in *Hypsicchinus*.

That the specimen from st. 207 is no *Prionechinus* has been stated above; unfortunately it is impossible to decide with certainty what it is, as all the pedicellariæ are wanting. The spicules are bihamate; the tube feet are remarkably broad at the base, corresponding to the uncommonly large pores. The spines are of the same structure as in *Prionechinus*. As no sufficient characters can be given of this form, I shall give it no name, but only separate it from *Prionechinus*.

From the Indian Ocean another species of *Prionechinus* has been described, *Pr. Agassizii* Wood-Mason & Alock (441); whether it really belongs to the genus *Prionechinus* cannot bee seen from the description, and no informations are given of the pedicellariæ or spicules; no figure is given. As the original description of the genus *Prionechinus*, as here shown, is anything but good and faultless, the referring to this genus must be considered uncertain, until a closer examination has been made with regard to the characters pointed out here.

Cottaldia forbesiana A. Ag. To the description of Agassiz I can add the following informations. The globiferous pedicellariæ (Pl. VII. Fig. 32), like those of *Prionechinus*, have only one, unpaired lateral tooth, and the edges of the blade are thickened, but not connected by cross-beams; the basal part is somewhat more rounded than in *Prionechinus*. The tridentate pedicellariæ (Pl. VII. Fig. 22. Pl. VIII. Fig. 33) resemble those of *Prionechinus*, but have only small teeth in the point of the blade. The valves join only with the points, and are wide apart below, when the pedicellaria is shut. The neck very short. The ophicephalous and triphyllous pedicellariæ (Pl. VII. Fig. 26) resemble those of *Prionechinus*. The stalks of the pedicellariæ are of the same structure as in *Prionechinus* and *Hypsicchinus*, only a little more dense. The spicules, as shown by Bell (50), are bihamate. The spines are thicker and not so sharply serrate as in *Hypsicchinus*, but the point is constructed as in the latter, only more rounded. — Whether this species really belongs to the genus *Cottaldia*, which has been established by Desor for some small fossil Echinids, must be regarded as very doubtful, as has also been observed by Agassiz himself. Upon the whole the referring of recent forms to genera established for fossil ones, is exceedingly problematic, if the tests do not show particularly characteristic features. It has even proved impossible to classify the recent species correctly after the tests and spines only, as has been shown above with regard to the Cidarids and Echinothurids, and it will be shown below that the fact is quite corresponding with regard to Echinometridæ and Triplechinidæ. Pomel (324) refers this species to the genus *Arbacina* established by him. As the type of this species he[1]) gives *Arbacia mouilis* (Ag.) that is to say, a fossil form, and here the same observation holds good as with regard to *Cottaldia*: we cannot prove at all that the recent form is the same genus, as we want the most important characters. It must be admitted, however, that *A. forbesiana* shows really a great

[1]) Revue des Échinodermes et de leur classification p. XLI. 1869 (?).

resemblance in the structure of the test to *A. monilis* (comp. Chall. Ech. Pl. VII. Fig. 15 with Pl. XVIII. Fig. 12. a in Desor: «Synopsis des Échinides fossiles», or with Pl. XV. Fig. 11 in Agassiz and Desor: «Catalogue raisonné»), and so I shall establish no new genus for this form, but for the present let it remain in the genus *Arbacina*.

Trigonocidaris albida A. Agass. The globiferous pedicellariæ (Pl. VII. Fig. 31) chiefly as in *Arbacina*, a single cross-beam may, however, be found between the edges of the blade; the poison gland large reaching almost to the articular surface. I have found no tridentate pedicellariæ in the specimen before me. The ophicephalous pedicellariæ are short-necked, with no special peculiarities. The triphyllous pedicellariæ are very small and of a rather peculiar form (Pl. VII. Fig. 23). The blade is rather broad, round, the edge exceedingly finely serrate (the serrations can only be seen under rather higher magnifying powers than those under which the figure is drawn). The spicules are bihamate (Pl. VII. Fig. 28), very few. The spines are constructed after the same type as those of *Hypsiechinus* and *Prionechinus*; the primary spines round the mouth are curved.

The difference between *Trigonocidaris* and *Prionechinus* seems to be very slight. The most important one seems to be that *Prionechinus* has no such grooves in the test as those of *Trigonocidaris*. To be sure, Agassiz does not mention the feature at all, and neither have I examined myself how the facts are in this respect; but I think that the very fact of none of us having observed such grooves, may be taken as a proof that they, at all events, are only slightly developed; if this was not the case they would certainly have been observed.

Whether *Trigonocidaris monolini* A. Ag. is a real *Trigonocidaris* cannot be decided after the one known specimen. Only ophicephalous and triphyllous pedicellariæ are found on it, and they show nothing remarkable; the latter are of the same peculiar form as in *Trigonoc. albida*, but the edge does not appear to be serrate, even under the highest magnifying powers. The ophicephalous ones are short-necked, and the stalk is constructed as in the other forms mentioned here. The spicules are bihamate, rather small and numerous (Pl. VII. Fig. 27). To be sure, this very peculiar Echinid will easily be recognised, even if our knowledge of its pedicellariæ is deficient.

Temnechinus maculatus A. Ag. The buccal membrane, as stated by Agassiz, is quite naked with the exception of the buccal plates; but it does not seem to have been observed that it contains a great many bihamate spicules. Also the spicules of the tube feet are bihamate. Koehler (229) has described the ophicephalous and globiferous pedicellariæ, not, however, with a sufficiently exact representation of the characteristic structure of the latter. The ophicephalous pedicellariæ are long-necked; Koehler thinks the valves to be uncommonly long, which does not appear to me to be the case; at all events they show no peculiar structure. The globiferous pedicellariæ, on the other hand, are very peculiar and interesting. The small poison glands are double, and separated through their whole length (Pl. VIII. Fig. 7), a feature which was hitherto quite unknown in the Echinids, but which I have also found in *Parasalenia* and *Strongylocentrotus erythrogrammus*. Whether this feature is a primitive one, is, I think, to be regarded as doubtful; at all events neither *Temnechinus*, *Parasalenia*, nor *Strongylocentrotus* can be regarded as primitive forms. In other Echinids the poison gland, to be sure, has a deep furrow above on the outside, and opens by a double canal into the end-tooth — at all events in *Sphærechinus* (v. Uexküll 406); but this does not appear to me

a sufficient proof of the original structure having been a double poison gland. We should then except to find a double poison gland in forms as *Hypsiechinus* and *Parechinus*; in these, however, it is not found — but on the contrary in such specialised forms as the three species mentioned above. More thorough examinations will be necessary in order to decide the question. The histological examinations hitherto made of the globiferous pedicellariæ, have chiefly been directed to *Sphærechinus* and *Echinus acutus*; a much broader base of the examinations is necessary. — The form of the valves is rather peculiar; the basal part is flatly widened, with rather sharp corners, the blade very narrow, almost tubiform, the edges being almost quite coalesced on the inside, so that only a series of small holes are found along the median line and one larger hole at the point; only one unpaired lateral tooth (Pl. VII. Fig. 30). The triphyllous pedicellariæ (Pl. VII. Fig. 24) are very small and resemble those of *Trigonocidaris*; no teeth are found in the edge.

Agassiz originally described this species under the name of *Genocidaris maculata*, later he thought that it ought to be referred to the genus *Temnechinus*, established by Forbes[1]) for some fossil forms with rather deep grooves in the sutures. The present species, however, has no such grooves; Agassiz also admits that it shows »very marked differences from the species of *Temnechinus* figured by Forbes» (Rev. of Ech. p. 286). But when the structure of the test is not the same in the fossil species and the recent one, we cannot be warranted in classing them together; even if the structure of the tests was identical, we might doubt whether they were the same species, for, as has constantly been shown by these examinations, identical structure of the test is no proof of near relationship. But when the structure of the test is so different, as the case is here, there can be no question of classing them together. Nor does it show any nearer relation to *Opechinus* Desor, to which genus it, according to Agassiz (Rev. of Ech. p. 286), is »closely allied»; *Opechinus* is a genuine Temnopleurid with deep grooves in the sutures. I must completely assent to the opinion of Pomel that this form ought to keep its original name of *Genocidaris maculata*.

This little Echinid, which was hitherto only known from the American side of the Atlantic and the Azores, is also found in the Mediterranean. In our museum four specimens of it are found taken at Syracuse on a depth of 12—15 fathoms by Dr. H. I. Hansen in 1893. Another species, *Temnechinus Scillæ*, from the Red Sea, has been described by Mazzetti (277—78).

By the name of *Arbacina Pallaryi* Gauthier (162) has described a little Echinid from the coasts of Algeria, but it cannot be seen from the description and the figures where this form is to be referred. Prof. Pallary has most kindly sent me some specimens of it, among others three which have been determined by Gauthier himself as *A. Pallaryi*. They proved to be *Genocidaris maculata*; thus the name of *Arbacina Pallaryi* may be struck out as a synonym. That it has no relation to the genus *Arbacina* is sufficiently evident from the fact that in *Arbacina* the base of the tubercle is smooth, as is expressly stated by Agassiz, Desor, and Pomel, and shown in the figures of *A. monilis* quoted above. But it is quite incredible that a form with a stellate tubercle-base should be of the same genus as the mentioned *Arbacina* with smooth tubercle-base.

It seems to be unquestionable that *Hypsiechinus* is most nearly related to the forms here mentioned; its spines, buccal membrane, and structure of the test reminds very much of those, especially

[1]) Monograph of the Echinodermata of the British Tertiaries. 1852.

Prionechinus and *Trigonocidaris*. Nevertheless its peculiar spicules and globiferous pedicellariæ show that the relation is not so very close. The globiferous pedicellariæ are quite similar to those of «*Echinus*» *miliaris*, but there can be no question of any nearer relation to this latter. On the other hand this form of pedicellariæ might indicate that it is a more primitive form than the other genera here mentioned, in which the globiferous pedicellariæ have only one unpaired lateral tooth. Also the spicules indicate that it is a more primitive form; bihamate or similar regular spicules are otherwise found in all «*Echinidæ*» and «*Echinometridæ*» (with the exception of *Stomopneustes*), but are wanting in *Cidaridæ*, *Salenidæ*, *Diadematidæ*, *Echinothuridæ*, and *Arbaciadæ*, where only more or less irregular fenestrated plates or thorny bows are found (Bell 50). Without entering on a nearer discussion of the relationship of these forms, I shall here only give a table of the mentioned genera, which may, I think, be of practical importance, as it is evident that these small forms have occasioned some difficulties to the systematists. A facilitation of the determination will, I hope, lead to the discovery of more related forms that may, no doubt, be found in the large, hitherto only little known tracts of the ocean. That *Genocidaris maculata* has hitherto been overlooked in the Mediterranean, or at all events misjudged, although it is, no doubt, rather commonly found in the Strait of Messina, presages that we may still expect many new discoveries of these interesting small forms.

Table of the Genera.

1.	The buccal membrane outside of the buccal plates covered by large plates..	2.
	— — — — - — — — naked	4.
2.	The globiferous pedicellariæ with the edges of the blade sharp, not connected by cross-beams; several lateral teeth on either side. The spines strongly thorny, those around the mouth curved; the spicules a little irregular, three-radiate, not bihamate	*Hypsiechinus.*
	The globiferous pedicellariæ with the edges of the blade thickened, with only one unpaired lateral tooth; the spicules bihamate.....	3.
3.	The test much grooved.....	*Trigonocidaris.*
	— — not —	*Prionechinus.*
4.	The globiferous pedicellariæ with the edges of the blade almost quite coalesced on the inside, so that only a series of small holes is left. One very large anal plate.....	*Genocidaris.*
	The globiferous pedicellariæ with the edges of the blade thickened, but not connected by cross-beams. No very large anal plate.....	*Arbacina.*

10. **Hypsiechinus coronatus** n. sp.

Pl. V. Fig. 1. Pl. VII. Figs. 1—20. Pl. VIII. Figs. 5, 9, 15, 17, 18, 24, 25, 38. Pl. XI. Fig. 6.

The test is flattened, more than twice as broad as high (the remarkably raised apical area not included); the outline most frequently beautifully round, sometimes a little pentagonal. It is not curved inward at the edge of the mouth. The mouth-slits indistinct, the peristome large. The apical

area is large, in ♂ and young specimens slightly raised, in the adult ♀ so much raised as to form a very conspicuous knob (Pl. VII. Figs. 1—4). When both the peristome and the apical area are wanting, the test resembles a little ring.

Diameter.	Height (apical area not included).	Diameter.		Greatest Breadth.		Number of plates.		Longest spines.	Sex.
		Peristome.	Apical area.	Ambulacral area.	I.-Ambulacral area.	Ambulacral area.	I.-Ambulacral area.		
9	3·5	4	5	2	3·5	8—9	7		♂
9	4	4	4·2	2	3·2	8	8		♂
8	3·5	4·5	4					7	♂
8	3·2	4	3·5	1·5	3	8—9	7—8		♀
8	3·5	3·5						5—6	♀
6·8	2·5	3·5	2·5	1·2	2·5	8—9	7—8		♀
4	1·8	2·5	2·2	1	1·8	5—6	5—6		
3	1·8	2	2					4	

All the measures are in millimetres.

The interambulacral areas are about twice as broad as the ambulacral ones; the boundaries between the plates are very indistinct, especially in the ambulacral areas; they are given too distinctly in the figures (Pl. VIII. Figs. 24—25). Near the apical area the ambulacral plates are single, farther down they are coalesced in the common way, three and three. Here one larger tubercle is found for each compound plate, and besides some quite small ones above each primary tubercle. The ambulacral plates are comparatively high, so that upon the whole the same number of ambulacral and interambulacral plates is found. The pores form almost a straight line, but are in reality trigeminate, which fact, however, is not distinct in the upper part of the area; the upper hole of each pair of pores is larger than the lower one. The interambulacral plates, especially above, are rather broad, the horizontal boundary line between the plates bends downward in the middle; the median line of the area is only slightly sinuate, likewise in the ambulacral areas. Each interambulacral plate has a not very conspicuous primary tubercle near the sinuate lower edge and besides some miliary tubercles. In ♂ the upper plates are almost smooth, in ♀ these plates are very richly provided with miliary tubercles. In the adult ♀ the test most frequently has an irregular, grooved-netshaped surface, especially between the close-set tubercles on the upper interambulacral plates.

The primary spines are in the adult specimens hardly as long as the diameter of the test, in small specimens somewhat longer than the diameter; the spines around the mouth are somewhat curved in the point. All the spines are strongly indented, and end in a little, conical point, surrounded by ca. 6 smaller points (Pl. VIII. Fig. 9); the actinal spines end irregularly truncate, presumably owing to wear (Pl. VIII. Fig. 17). In transverse sections (Pl. XI. Fig. 6) the spines are seen to consist of 6 longitudinal ridges the outer edge of which is somewhat widened; they are united with each other so as to form a little cavity in the middle, and 6 smaller cavities in a circle round this.

The buccal membrane is covered by large plates, which under the microscope are seen to be common, almost smooth fenestrated plates. Those inside of the buccal plates are smaller and quite smooth, and the plates decrease likewise in size towards the edge of the peristome (Pl. VII. Figs. 11, 15). The buccal plates are more complicate, and form a little arch, as it were, over the base of the tube

foot, with the opening directed towards the mouth. The two buccal tube feet are not placed in quite the same line, but one a little outside of the other; this is most distinctly seen in younger specimens, and in quite small young ones of a diameter of up to 2—3^{mm} only one tube foot of each pair is developed at all. Also in a single specimen of a diameter of 6^{mm} only one tube foot of each pair of mouth-feet is developed; sometimes it may also be seen that one tube foot is quite wanting in one pair, rudimentary in another, while both the tube feet are well developed in the other pairs. — A similar feature is found, as stated by Agassiz, in *Prionechinus*, or, at all events, in a form by Agassiz wrongly referred to *Prionechinus* (see above p. 82—83). Spicules are not found in the buccal membrane, the small gills contain the common irregular calcareous plates (Pl. VII. Fig. 12), only, however, in the basal part; spines or pedicellariæ are not found on the buccal membrane.

The apical area is very peculiar, especially in ♀ — a well marked sexual difference being found. In ♂ the apical area is only slightly raised in the middle (Pl. VII. Fig. 9); the ocular plates are small, all widely separated from the periproct, the genital plates are much larger, truncate, rather regularly septangular, only the boundary line towards the ocular plates somewhat curved. Each genital plate has one rather strong tubercle or a pair of such tubercles at the inner edge, the ocular plates are quite smooth, or more rarely with a few, very small miliary tubercles. The genital pore is very small, situated about in the middle of the plate. The madreporite is very little conspicuous, has only few (2—3) pores. The periproct is covered by one larger plate and some smaller ones; in quite small specimens the large plate covers the whole periproct.

In ♀ the mutual relation of the plates is chiefly the same as in ♂, but the ocular plates and especially the genital ones have been very much elongated and bent upward, so that the whole apical area is raised like a knob. The lower part of the genital plates and the ocular plates in their whole extent are quite smooth, but the inner (upper) part of the genital plates is very richly set with tubercles forming, as it were, a crown round the upper edge of the knob (Pl. VII. Fig. 1). The periproct as in ♂, without tubercles. The genital pores are large, and situated nearer to the outer (lower) edge.

Of pedicellariæ only three kinds are found: globiferous, ophicephalous, and triphyllous pedicellariæ. Tridentate pedicellariæ are wanting — at all events in the specimens in hand. The globiferous pedicellariæ (Pl. VII. Figs. 19, 20) remind very much of those in *Echinus miliaris*. The upper ends of the apophysis continue directly in the edges of the blade, which are sharp and run out into 2—4 teeth on either side; there are no cross-beams connecting the edges across the hollow inside of the blade; the end-tooth especially large, of the structure typical in the Echinids. The glands are quite small reaching only to the basal part; no neck. The ophicephalous pedicellariæ (Pl. VII. Fig. 18, Pl. VIII. Fig. 38) have a quite short neck, but otherwise they do not, any more than the triphyllous pedicellariæ (Pl. VII. Fig. 16), show conspicuous peculiarities. It is, however, to be noted that in the triphyllous pedicellariæ the edge is quite smooth. — The stalks of the pedicellariæ consist of longitudinal fibres connected by cross-beams to a rather compact reticulation; they are not hollow; they increase evenly in strength downward, but are not widened at the base. — The sphæridiæ (Pl. VII. Fig. 17) show no marked peculiarities; they are slightly spinulous in the point, short-stalked, often somewhat irregular, and more globiform than the figured one.

The tube feet have a typical sucking disk, as in an *Echinus*, but generally there are only three leaves in the rosette (Pl. VII. Fig. 10). In the mouth feet the sucking disk, as in an *Echinus*, is an oval, continuous ring, of a far more complicate structure than the parts of the sucking disk in the other tube feet. The spicules (Pl. VII. Fig. 13) are small three-radiate, somewhat irregular bodies. In the lower part of the tube feet almost none are found, nearest to the sucking disk they are more numerous, and are here often a little branched and larger. No spicules are found in the skin at the base of the spines, nor in the genital organs.

The dental apparatus is of the structure common in the Echinoids; on the other hand the auriculæ are peculiar, only consisting of a pair of small processes, not joining above. None of the specimens in hand show indication of any coloration.

This little Echinid is especially interesting by nursing its brood — a fact hitherto unknown among the regular Echinids, with the exception of two Cidarids: *Stereocidaris nutrix* and *canaliculata*. As mentioned in the description there are in ♀ a great many tubercles on the upper coronal plates, and on the upper edge of the genital plates. The spines of these latter are bent downwards thus joining those of the upper coronal plates. By this means a protected space is formed round the knob-like process; the genital apertures open into this space, and here then the eggs and young are placed protected by the spines (Pl. VII. Fig. 5). The number of the eggs varies from 3—7; they are about $0{\cdot}5^{mm}$ in diameter. Sometimes they are all in the same stage of development, sometimes may be found in the same individual almost quite developed young and eggs or embryos where the first skeletal structures have not yet been formed.

It was not possible, by means of the material in hand, to study the whole development of the young, only a few stages have been given (Pl. VII. Figs. 6—8). In the youngest stage (Fig. 6) the first beginning of the teeth is seen; the buccal plates are begun, and the primary tentacles may be discerned through a plate, which I take to be the terminal plate (the ocular plate). Between each pair of buccal plates, a little outside, a larger unpaired plate is found, the basal plate (the genital plate?). In the following stage (Fig. 7) the different parts of the dental apparatus are begun, and in some of the buccal plates a larger hole has appeared. In the oldest stage (Fig. 8), in each pair of buccal plates one large opening has been formed for the buccal tube foot, and this feature of only one tube foot being developed, is still found, as mentioned above, in young specimens of a diameter of $2—3^{mm}$, and sometimes in still larger specimens. The smallest individuals, in which I have found both buccal tube feet developed, had a diameter of 4^{mm}. In the oldest stage figured, the five primary tube feet are seen distinctly, and the five first spines, interambulacral ones, are begun. In corresponding stages only one large anal plate is found (Pl. VII. Fig. 14), which may be perforated by a larger opening; accordingly it seems quite to encompass the anal aperture.

Of this especially interesting little Echinid several specimens have been taken by the Ingolf-Expedition on the following stations:

St. 73	(62° 58′	N. Lat.	23° 28′	W. L.	486	fathoms.	5°1	bottom temp.	Bottom [?]).	1	specimen.
— 78	(60° 37′	—	27° 52′	—	799	—	4°1	—	Mud.	). 40	—
— 81	(61° 44′	—	27° 11′	—	485	—	5°7	—	?	). 18	—
— 84	(62° 58′	—	25° 24′	—	633	—	4°4	—	?	). 15	—

St. 90 (64° 45′ N. Lat. 29° 06′ W. L. 568 fathoms. 4° bottom temp. Mud.). 2 specimens.
— 97 (65° 28′ — 27° 39′ — 450 — 5°1 — —). 3 —

Further three specimens have been taken by Ryder (1888) on 553 fathoms in the Denmark Strait.

Thus this species also belongs to the rich archibenthal fauna of the northern Atlantic; it is scarcely to be doubted that it is also found in other places than in the Denmark Strait and on the ridge south of Iceland.

On the Fam. Echinometradæ Gray and the Subfam. Triplechinidæ A. Agass.

It has been shown in the preceding, how little successful the previous attempts at a classification of the Cidarids and Echinothurids have been. It is still worse with regard to the forms that are to be treated here. In the former only the species and genera were confused; here not only the species and genera, but also the families have been mingled to such a degree, that species which have proved by a closer examination to belong to at least three different families, have been referred to the same genus (*Strongylocentrotus*). The «family» *Echinometridæ* and the «subfamily» *Triplechinidæ* prove to be interwoven to such a degree, that it is impossible to treat each group separately. I have examined almost all the genera and species referred to these groups, and have found the relation between these numerous forms that all look rather uniform, to be widely different from what has formerly been supposed — although these suppositions have otherwise been sufficiently different.

The earlier attempts at a classification of the forms belonging here, have been put together by Lütken, to whose paper I shall only here refer[1]). Gray is the first author, who has tried to arrange the genera into families; he establishes the following system[2]):

Fam. Hipponoidæ. The ambulacral areas as broad as the interambulacral areas; the pores form three separate series. — *Amblypneustes*, *Boletia*, *Hipponoë*, *Holopneustes*.

Fam. Echinidæ. The ambulacral areas half as broad as the interambulacral areas; the pores form arcs of 3. A. With pores at the sutures. *Mespilia*, *Microcyphus*, *Salmacis*, *Temnopleurus*. B. Without pores at the sutures. *Echinus*, *Psammechinus*, *Heliocidaris*.

Fam. Echinometradæ. The ambulacral areas half as broad as the interambulacral areas; the pores in arcs of 4 or more. A. Test round: *Strongylocentrotus*. B. Test oblong: *Echinometra*, *Holocentronotus*, *Colobocentrotus*.

In the following time repeated attempts have been made to improve the system, but none of these attempts have been very successful. A short survey of these systems is given here.

Troschel (403. p. 297). (No genera are named.)

Fam. Echinidæ. Pores trigeminate; mouth-slits insignificant; no ocular plate reaches the periproct.

Fam. Tripneustidæ. Pores trigeminate, mouth-slits deeper than broad; two ocular plates reach the periproct.

[1]) Bidrag til Kundskab om Echiniderne. Kobenhavn 1864. p. 84 f. (Vid. Medd. Naturh. Foren. Kbhvn. 1863.)

[2]) An arrangement of the families of Echinida, with descriptions of some new Genera and species. Proc. Zool. Soc. 1855. p. 35—39.

Fam. Toxopneustidæ. Pores multigeminate; the test round or pentagonal.

Fam. Echinometradæ. Pores multigeminate; the test elliptical.

Agassiz (Revision of Echini).

Fam. Echinometradæ. Pores multigeminate — *Colobocentrotus*, *Heterocentrotus*, *Echinometra*, *Parasalenia*, *Stomopneustes*, *Strongylocentrotus* (Subgen. *Sphærechinus*, *Pseudoboletia*), *Echinostrephus*.

Fam. Echinidæ. Pores trigeminate. (Subfam. Temnopleuridæ.)

Subfam. Triplechinidæ. *Phymosoma*, *Hemipedina*, *Echinus*, *Toxopneustes*, *Hipponoë*, *Evechinus*.

Bell (40).

Fam. Echinidæ.

Group I. Test round. Echininæ.

α) The ambulacral plates formed of three primary plates. *Echinus* etc.

β) — — — — four or more primary plates. *Strongylocentrotus* etc.

Group II. The morphological axis obliquely to the longitudinal axis. Echinometrinæ.

— III. — — — at right angles to the longitudinal axis. Heterocentrotinæ.

Pomel (324). (In this account of the system of Pomel the fossil genera are omitted).

Les Echinométriens. *Colobocentrotus*, *Podophora*, *Heterocentrotus*, *Acrocladia*, *Echinometra*, *Ellipsechinus*, *Parasalenia*.

Les Héliocidariens. *Strongylocentrotus*, *Toxocidaris* (= *Anthocidaris* Ltk.), *Loxechinus*, *Echinostrephus*, *Stomopneustes*, *Heliocidaris* (= *Evechinus*), *Holopneustes*.

Les Schizechiniens. *Toxopneustes* (= *Boletia*), *Pseudoboletia*, *Hipponoë*, *Sphærechinus*, *Anapesus* (= *Lytechinus* Ag., *Psilechinus* Ltk., *Schizechinus* Pomel).

Les Psammechiniens. *Echinus*, *Psammechinus* (*miliaris* etc.), *Arbacina (forbesiana)*.

Duncan (132).

Fam. Echinometridæ.

Subfam. Echinometrinæ. *Heterocentrotus*, *Colobocentrotus*, *Echinometra*, *Stomopneustes*, *Parasalenia*.

Subfam. Polyporinæ. *Strongylocentrotus*, *Sphærechinus*, *Echinostrephus*, *Pseudoboletia*.

Fam. Echinidæ. *Echinus* (Subgen. *Psammechinus*), *Toxopneustes*, *Boletia*, *Tripneustes* (Subgen. *Evechinus*).

I. W. Gregory[1]).

Fam. Triplechinidæ. *Echinus*, *Psammechinus*, *Tripneustes* (= *Hipponoë*), *Toxopneustes*, *Boletia*, *Evechinus*.

Fam. Strongylocentrotidæ. *Strongylocentrotus*, *Sphærechinus*, *Pseudoboletia*.

Fam. Echinometridæ. *Echinometra*, *Stomopneustes*, *Heterocentrotus*, *Colobocentrotus*, *Parasalenia*.

[1]) Echinoidea, in «A treatise on Zoology, edited by E. Ray Lankester . Part. III. Echinoderma. London. 1900.

Lambert (238. a).

Fam. Echinometridæ.

Subfam. Echininæ.

Tribus. Oligoporinæ. *Triplechinæ*, *Schizechinæ*.

— Polyporinæ. *Sphærechinæ*. *Heliocidarinæ*, *Acrocladinæ*.

The characters, on which the systems hitherto established have chiefly been based, are: the number of the pores, the breadth of the ambulacral areas, the slits and form of the test. Desor[2]) is the first author, who uses the number of the pores as a principle of division, dividing the forms belonging here into «Oligopori» and «Polypori». In this he is followed by all the later authors (even if they do not use the expressions of «Oligopori» and «Polypori») with the exception of Pomel and Bell. In the essay on the Echinometrids quoted above, Bell has given a thorough criticism of this feature, and has shown that it is by no means a natural principle of division, in spite of the assertion of Agassiz (Rev. of Ech. p. 423) that «this division, although it appears a numerical one, is yet one of great physiological importance, as the mode of growth of the poriferous zone in these two families is totally unlike». I must assert, still more strongly than has been done by Bell, that this division is a quite numerical one, not at all corresponding to the natural relation of the forms. Moreover it cannot be carried through at all, some species having on the lower ambulacral plates (i. e. as young individuals) trigeminate pores, on the others multigeminate ones. Besides the instances mentioned by Bell: *Echinostrephus*, *Strongylocentr. drobachiensis*, *Echinometra macrostoma* and other *Echinometra*-species, I can name «*Strongylocentrotus*» *albus* and *lividus* that have also only three pairs of pores in the lower ambulacral plates. Also in young *Sphærechinus granularis* trigeminate pores may be found in the lower plates, and this feature, I think, may be taken to be found in all polypore forms. When Bell, in his group of *Echininæ*, uses the number of the pores as a base of further subdivision, I cannot agree with him; so much importance is not due to this feature, it can by no means be regarded as more than a generic character, and I should not wonder, if in some cases it should prove to be no more than a specific character. At all events the number of the pores has only slight importance or none at all with regard to the natural grouping of the genera; Pomel seems to be the only author, who has hitherto seen this fact.

The breadth of the ambulacral areas is used by Gray as a distinguishing character. That it is especially unfortunate is shown by the result, as Gray thereby is brought to the uniting of *Amblypneustes*, *Holopneustes*, *Boletia*, and *Hipponoë* into one family, what is absolutely wrong; neither has any author followed him in this respect.

The slits of the test are used by Pomel and Troschel, by the latter, however, only as a subordinate character, the number of the pores being used as the first principle of division, so that only the forms with trigeminate pores are referred to his family *Tripneustidæ*, while *Sphærechinus* and *Pseudoboletia* are referred to the family *Toxopneustidæ*. — Agassiz says of the deep slits of the test in *Sphærechinus* (Rev. of Ech. p. 451): «the presence of deep, sharp cuts in the actinal system ... are simply quantitative characters, the value of which a better acquaintance with the subject will deter-

[1]) Synopsis des Echinides fossiles. 1855.

mine. The better acquaintance, however, does not grant that Agassiz is right, on the contrary we find that we have here an especially important systematic character. All the genera with deep slits of the test agree also in other respects, as will be shown hereafter, and form a separate, distinctly limited group (that is to say in such a way that not all the forms belonging to this group have deep slits of the test, but that all forms with deep slits of the test belong to this group; for in some small forms no doubt belonging here, the slits of the test are not very large). The group of »Les Schizechiniens» of Pomel is completely correct — the only correct thing in all the systems hitherto given.

The form of the test plays a very great part in the previous systems; that all oblong forms belong to the Echinometridæ is considered as a matter of course. Even by Agassiz, who characterizes the family *Echinometridæ* as »having always more than three pairs of pores to each arc», *Parasalenia* is referred here, although it has only three pairs of pores in each arc; but it is oblong, and accordingly it must be an Echinometrid! That the obliquity, however, is a character insufficient for being the base of a family *Echinometridæ*, has been justly emphasized by Agassiz (Rev. of Ech. p. 436). In *Stomopneustes* there is in large individuals an indication of obliquity, and »there are in *Echinometra*, in one and the same species, specimens in which the elongation of the axis cannot be traced». — Already Stewart (381) has called attention to the fact that *Parasalenia* is distinguished from the *Echinometridæ*, »to which family most would, I should think, refer *Parasalenia*», in the structure of the spines and the pedicellariæ. According to my examinations that quite corroborate the observations of Stewart, there can be no question of referring *Parasalenia* to the Echinometrids. And so the obliquity of the test must be dropped as a reliable character; not every oblique Echinid can beforehand be taken to be an Echinometrid. That the obliquity is not the same, the morphological axis not being in the same proportion to the longitudinal axis in all the oblique forms, has been shown by Joh. Müller[1]), and again emphasized by Bell (op. cit.), who according to this fact distinguishes between *Echinometrinæ* and *Heterocentrotinæ*.

As consequently none of the characters hitherto used, with the only exception of the slits of the test, have any greater systematic importance, we must seek other characters, by means of which we can set this chaos right. The characters, of which there can be any question, are the following: the structure of the test, the apical area, the spines, the gills, the buccal membrane, the inner anatomical structures, especially the dental apparatus and the auriculæ, the sphæridiæ, the spicules, and the pedicellariæ.

The structure of the test cannot be expected to yield more important characters; if such were to be found they would no doubt have been found long ago, as the attention has hitherto almost exclusively been directed to the form of the test, the arrangement of the tubercles etc. in the descriptions. The systematic attempts mentioned above, show to a sufficient degree of how little value the characters found here are. One feature of not quite small importance is found, however, which seems to have been quite overlooked by almost all later authors, viz. that in several forms only every other ambulacral plate has a primary tubercle, while in others every ambulacral plate is provided with such a one. Only in Lütken (op. cit. p. 87) I have found a remark »that it is not always the case that

[1]) Über den Bau der Echinodermen. Abh. d. Berl. Akad. d. Wiss. 1853. p. 128.

every (ambulacral) plate has its primary tubercle well developed. He has not, however, used this feature as a systematic character. On the other hand Düben & Koren[1]) and G. O. Sars[2]) have carefully noted this fact in their descriptions, and Koehler (233. a) has recently given prominence to this feature in his description of *Stereehinus antarcticus*.

The apical area, no doubt, shows some difference: sometimes all the ocular plates are shut off from the periproct, sometimes one or more reach to it. That no greater importance can be attached to this feature is a sure fact, which may be seen with especial clearness from a case as that of *Stereehinus antarcticus* (= *Ech. margaritaceus*), where in young individuals all the ocular plates are shut off from the periproct, while in the adult they reach, all of them, to it (Koehler, 233. a).

The structure of the spines does not seem to yield very good systematic characters. Mackintosh (265) has given numerous excellent figures of transverse sections of spines from a great number of species. But I do not think that he has found so great and reliable differences in this feature, that it can be used as a criterion of a nearer or farther relation between the separate forms. Especially I think that a greater variation in the structure of the spines of the same species may be found, than is to be seen from the work quoted. Also the secondary spines of the different species may deserve a nearer examination. Hesse (195. a) has recently made thorough studies of the structure of Echinid-spines, especially the fossil ones. He arrives at the result, «dass fast jede der einzelnen Familien der Echinoideen ihren eigenen mikrostrukturellen Stacheltypus besitzt, und dass die histologischen Verhältnisse der Stacheln ein wichtiges systematisches Kennzeichen für die Familien und in gewissen Zügen von secundärer Werthigkeit oft sogar für die Gattungen, ja für einzelne Arten der Seeigel liefern (p. 204). He establishes 6 types: *Cidaris*, *Echinus*, *Diadema*, *Clypeaster*, *Scutellidæ*, and *Spatangus*, and if we take the families to be of a corresponding extent, the spines may be seen to yield family-characters. The type of *Echinus* comprises both Temnopleurids, Echinometrids, and Echinids s. str. He divides them into two parts, a) with the radial septa not perforated, b) with the radial septa perforated. To the first division belongs among others *Toxopneustes pileolus*, to the second *Hipponoë esculenta* — two forms that are no doubt very nearly related. Such things prove how little value is to be ascribed to this character. Upon the whole it must be said that the structures mentioned by Hesse will scarcely be of any great importance with regard to the recent Echinids; with regard to the fossil ones, on the other hand, they will, no doubt, be of some importance, as we may always from the structure get some instruction with regard to the correct referring of the animal or the single spine, even if it will only in rare cases be possible to get at the genus or the species. — Rothpletz (346. p. 289) says of Radioli cancellati (corresponding to the «polycyclic acanthosphenote» spines of Mackintosh): «Nach Agassiz wäre dieser letzte Typus auf die Familie der *Echinometradæ* beschränkt, während der zweite Typus (Rad. radiati) allen übrigen Familien mit Ausnahme der Cidariden und Saleniden zukäme». As far as I can see Agassiz has said no such thing; in Rev. of Echini (p. 654) he says: «In the *Echinometradæ* we find the concentric rings most distinctly developed»; but that is

[1]) Skandinaviens Echinodermer. Vet. Akad. Handl. 1844.

[2]) Nye Echinodermer fra den norske Kyst. Vidensk. Selsk. Forhandl. 1871. p. 23 (in the description of *Ech. depressus* [= *norvegicus*]).

not the same as what Rothpletz has made of it. At all events Hesse is right, when he says that the »cancellate» structure is only »compliciertere Wachsthumserscheinungen an Stacheln seines zweiten Bauplanes, so dass die Stacheln ein und derselben Species, z. B. von *Strongylocentrotus albus* Ag. .... je nach dem Stadium ihrer Verdickung theils zu den Radiaten, theils zu den Cancellaten zu rechnen sein würden» (op. cit. p. 192). — To judge by what has hitherto been brought to light, we may scarcely expect to find features of any greater systematic importance in the structure of the spines with regard to the forms treated of here.

The gills will scarcely present peculiarities that may be used as systematic characters of greater importance. They generally contain some irregular spicules and fenestrated plates, which are in the lower part rather large and pass evenly into the plates of the buccal membrane; towards the ends of the branches they become smaller and more irregular, at last only branched calcareous needles. Common bihamate spicules are most frequently found together with these, sometimes in very great numbers (*Pseudoboletia*). *Heterocentrotus* and *Colobocentrotus* are distinguished by having pedicellariæ on the gills (placed on the larger fenestrated plates). In *Stomopneustes* only small three-radiate spicules are found in the gills (Pl. XVII. Fig. 13). — The sphæridiæ are very similar; their shape, number, or position can in no way be used as distinguishing characters between species, genera, or greater groups within this division of the Echinids.

The buccal membrane may be covered with plates, or naked, and this feature has played no small part in the classification, and will also persistently be of importance. It is, however, to be observed that it cannot always be seen directly whether plates are found in the buccal membrane or not. Often it looks quite smooth and naked — as for instance in *Echinus acutus* — but if a piece of it is cleared in potash or Canada balsam, it is seen to be quite full of larger or smaller, simple fenestrated plates; only when these plates carry pedicellariæ they become more complicate, and may then be seen on the dried skin. Thus a microscopic examination is necessary in order to ascertain whether plates are found in the buccal membrane or not. Most frequently among the fenestrated plates more or fewer spicules of the common bihamate form are found. The part inside of the buccal plates generally contains numerous smaller fenestrated plates, arranged more or less radially; these plates are upon the whole more simply constructed than those outside the buccal plates. In several species the buccal membrane is almost or quite naked (with the exception of the buccal plates), for instance *Echinus magellanicus*, *albocinctus*, *Robillardi*. In some species small spines are found on the buccal plates (for instance *Ech. esculentus*), and in *Pseudoboletia*, *Heterocentrotus*, and *Colobocentrotus* spines are even found in the plates of the buccal membrane outside the buccal plates.

The inner anatomical structures are especially little known in the different genera, with the exception of the dental apparatus and auriculæ. These, however, show a so similar structure, that important differences that might be of systematic significance, are scarcely to be found, and as to the other anatomical features, it is still more improbable that here should be found differences of any importance — apart from the fact that it would be very unpractical, if the inner anatomy was to be much used in the classification. Thus we have only left spicules and pedicellariæ — but here we also find what we want.

Perrier[1]) and Stewart[2]) have given informations of the spicules in several genera and species, and especially Stewart thinks that they will be found to afford most valuable and interesting additional points of generic and specific distinction. I must think it very improbable that good specific characters should be found in the form of the spicules; as far as my examinations reach they are very similar in all the species belonging to the same genus. On the other hand I quite agree with Stewart that the spicules yield valuable generic characters, and even excellent family characters. — The most common type is the simple, c-shaped, bihamate form; it is found in *Echinus* and *Echinometra* and the genera more nearly allied to these. In *Strongylocentrotus drobachiensis* and some other *Strongylocentrotus*-species the form is the same, only that here the spicules are a little branched in the ends (Pl. XX. Fig. 12). A very peculiar form of spicules is found in *Toxopneustes*, *Pseudoboletia*, *Sphærechinus*, and upon the whole in the forms with deep mouth-slits. They are dumb-bell-shaped, as two small balls connected by a short bar (Pl. XXI. Fig. 28 etc.). In *Sphærechinus* they resemble more the common bihamate spicules, but they are not at all pointed at the ends. Also a few typical bihamate spicules may be found among the others; this is also the case in *Strongylocentrotus*. Sometimes all possible stages of development of these spicules may be found, from a little ball to the form of the dumb-bell, and farther to the bihamate form (Pl. XXI. Fig. 31). That these forms are really developmental stages can, I think, scarcely be doubted. It is evident that a considerable rearrangement of the mass of lime must take place; but a similar resorption and new deposition of the lime is already known from Théels examinations of the resorption of the larval skeleton in the Echinoderms[3]). The form of spicules mentioned here is an excellent character of the family *Toxopneustidæ* (see below). Another peculiar form of spicules is found in *Parasalenia* and *Anthocidaris*; they are arcuate, with 1—2 small projections in the middle (Pl. XXI. Figs. 30, 32). Stewart calls this form of spicules biacerate. Also common bihamate spicules are found together with these, but in small numbers. A quite unique form of spicules is found in *Stomopneustes*; they are of two kinds: smaller, irregular fenestrated plates, and large, thorny, perforated tubes that may be a little branched (Stewart. Op. cit. Pl. L. Fig. 1).

The spicules are especially found in the tube feet, but also in the skin round the pedicellariæ (especially the globiferous ones), both on the stalk, the neck, and the head, and round the base of the spines they occur frequently. In the gills and the buccal membrane bihamate spicules are often found together with the more or less irregular fenestrated plates that are commonly found here. Also the inner organs are often richly provided with spicules that may be of a very irregular form, as has been shown by Stewart with regard to *Echinometra*. This, however, is of no practical importance in the classification where regard must chiefly be paid to the regular spicules of constant form in tube feet and pedicellariæ.

With regard to the pedicellariæ we have some good informations, especially in the works by Perrier and Agassiz. From these informations it is evident that an abundance of peculiar structures may be found here which are, no doubt, of great systematic importance. Thus Perrier has

[1]) Recherches sur les Pedicellaires et les Ambulacres des Astéries et des Oursins. Ann. Sc. nat. 5. Série. Zool. T. XII—XIII. 1869—70.

[2]) On the Spicula of the Regular Echinoidea. Trans. Linn. Soc. XXV. 1865.

[3]) Notes on the formation and absorption of the skeleton in Echinoderms. Ofvers. Kgl. Vet Akad. Förh. 1894.

rightly mentioned as a character of the Echinometrids that the globiferous pedicellariæ se termine(nt) par deux crochets, mais ces deux crochets naissent à des hauteurs différentes, quoique assez rapprochés du sommet du Pédicellaire. Even if Perrier has not understood this feature quite correctly, his figures are sufficiently clear and good. Accordingly no excuse can be found for the later authors, when they have overlooked this excellent character and in stead of it have stuck to the useless ones: the number of the pores and the form of the test. If they had made use of this character, they might have avoided the many systematical errors they have now fallen into. Beyond the peculiarity of the globiferous pedicellariæ of the Echinometrids emphasized by Perrier, no attempts, as far as I know, have been made to find other characters in the structure of the pedicellariæ that might be used for a limitation of larger or smaller groups inside this difficult division of the Echinids. The reason why no such characters have hitherto been found, is partly that far too few genera and species have been examined, partly that the examinations have not been made with sufficient exactness. My examinations have shown that in the structure of the pedicellariæ such peculiarities are found as yield excellent characters, by which the genera may be grouped.

In *Echinus miliaris* and some other species the blade of the globiferous pedicellariæ is provided with a larger or smaller number of teeth on either side; the edge is not thickened, but thin and sharp, and continues directly into the teeth; there are no cross-beams connecting the edges across the inside of the blade (Pl. XVII. Figs. 1, 7). In *Echinus esculentus* a. o. the edges are connected by cross-beams across the inside of the blade; they may be few and narrow, or so strongly developed, that the inside of the blade is almost quite covered with the exception of a series of larger or smaller holes along the median line. One or more pairs of lateral teeth are found placed on the thickened edge, but they do not form a direct continuation of it as in the preceding form (Pl. XVIII. Figs. 2, 3, etc.). — In *Echinometra* and the forms allied to it, as already mentioned, only one large lateral tooth is found on one side (Pl. XIX. Figs. 4, 13), and in *Strongylocentrotus*, *Sphærechinus* etc. no lateral teeth are found at all (Pl. XX. Figs. 14, 16, 26, etc.), only a little obliquity near the point shows that this form must be regarded as a further development of the pedicellaria that is provided with one unpaired lateral tooth, — not so much the strongly modified form in *Echinometra* as the less modified form in »*Ech.*» *albocinctus*. Besides these differences in the structure of the valves, also a few peculiarities in the structure of the stalk and in the neck are to be noted. In most genera the stalk consists of numerous long calcareous threads connected with each other by a few cross-beams; in some forms, *Strongylocentrotus drobachiensis* and its nearest relations, it is a thin perforated tube. In most forms the neck is quite short, or, more strictly speaking, quite wanting, in a few ones — also the *Strong. drobachiensis*-group — there is a long neck provided with powerful longitudinal and circular muscles (Pl. XX. Figs. 25, 29).

The other pedicellariæ seem only to contribute little to the limitation of the genera, still less to the characterization of the larger groups; on the other hand the tridentate and ophicephalous pedicellariæ yield often excellent specific characters. The triphyllous pedicellariæ are exceedingly similar, and yield scarcely any sufficiently certain systematic character, with one exception: *Evechinus chloroticus*; in this latter some digitate prolongations pass from the upper end of the apophysis over the blade (Pl. XIX. Fig. 29), a quite unique feature. As a common feature may be noted that the edge is

not serrate, and that the apophysis does not widen to a cover-plate, contrary to the triphyllous pedicellariæ of the Echinothurids. All four kinds of pedicellariæ are certainly found in every species; but of some species individuals may often be found, where globiferous or tridentate pedicellariæ (sometimes both forms) are quite wanting or very few in number (for instance *Echinus Alexandri*). This fact, of course, is an unfortunate circumstance, but the value of the pedicellariæ as systematic characters are not otherwise lessened by it.

If we now examine the genera and species referred to «*Triplechinidæ*» and «*Echinometradæ*» with special regard to the features described above, we shall get a view of their relations very different from the views expressed in the above mentioned systems.

The genus *Echinus* is notorious for its difficulty. A great many species have been described, but most frequently the descriptions are insufficient, so that the species cannot be recognized by them. One species, *Ech. acutus*, is very varying, and has occasioned the establishing of a great many species, which nobody has been able to recognize with certainty, and by which the confusion has only been increased. But even excellently characterized species, as for instance *E. elegans*, have often been confounded with other species, what I have repeatedly been able to substantiate; what is hitherto stated with regard to the distribution of the *Echinus*-species, must accordingly be used with great caution. The reason of all these difficulties is almost exclusively to be found in the literature: an exact examination of the animals themselves shows that the species upon the whole have rather distinct characters.

The following species are referred to the genus *Echinus*: *miliaris* Müll., *microtuberculatus* Blv., *angulosus* (Leske), *esculentus* L., *acutus* Lamk., *norvegicus* Düb. Kor., *Flemingii* Forb., *microstoma* Wyv. Thoms., *melo* Lamk., *elegans* Düb. Kor., *gracilis* Ag., *Wallisi* Ag., *lucidus* Döderl., *Robillardi* Loriol, *darnleyensis* Woods, *magellanicus* Phil., *margaritaceus* Lamk., *horridus* Ag., *Alexandri* Dan. Kor., *albocinctus* Hutton, *diadema* Studer, *Neumayeri* Meissner, *multicolor* Yoshiwara. A great many older names are cited as synonyms to several of these species in Agassiz's «Revision of Echini»; a renewed examination of the type specimens of these «species» with especial regard to the pedicellariæ might perhaps give other results than those of Agassiz; but until such examinations have been made, we must build on the results laid down in «Rev. of Ech.». Of all the above mentioned species, with the exception of *Ech. multicolor*, I have had occasion to examine authentic specimens, of *Ech. horridus*, *Neumayeri*, and *Alexandri* even the type specimens. The result is a considerable reduction of the number of species in the genus *Echinus*, some of the mentioned species being dropped as synonyms, some proving to belong to other genera.

As the type of the genus *Echinus* *E. esculentus* must be put down, the only one of the species established by Linné. Of its characters the following ones must be mentioned here. Only every other ambulacral plate carries a primary tubercle (in large specimens often 2—3 plates without primary tubercle follow each other). All the ocular plates are shut off from the anal area. The buccal membrane with numerous small and larger plates; spines on the buccal plates. The globiferous pedicellariæ without neck, the blade with a lateral tooth on either side, the edges connected across the inside. The tridentate pedicellariæ (Pl. XVIII. Fig. 20) long, narrow, the edge set with numerous small teeth

arranged in transverse series. The stalk of the pedicellariæ consists of long calcareous threads connected by few cross-beams. Spicules bihamate.

With this species must be classed *Ech. melo* and *acutus* (under which *E. Flemingii*, *norvegicus*, and *microstoma* are to be named as synonyms, the reasons of which will be given hereafter in the description of *Ech. acutus*). They are distinguished from *E. esculentus* by having fewer and longer spines, by wanting spines on the buccal plates, and by the plates in the buccal membrane being fine and quite imbedded in the skin, so that it looks as if the buccal membrane were naked. Further primary tubercles are also here generally wanting in more or fewer interambulacral plates besides in every other ambulacral plate. The difference between *melo* and *acutus* is very slight, they seem only to be differing in form and colour — perhaps they cannot upon the whole be kept as distinct species (for particulars see under the description of *Ech. acutus*). The pedicellariæ and spicules essentially as in *Ech. esculentus*.

Ech. elegans. It seems almost hopeless to attempt to distinguish the species of *Echinus* known as *E. elegans*, *E. norvegicus*, *E. melo*, and *E. Flemingii*», Agassiz says (»Blake» Echini. p. 39), and also Wyv. Thomson classes *Ech. elegans* among the »critical species» (395. p. 744). In this statement I cannot at all agree with the two celebrated authors. *Ech. elegans* is very different from *Ech. acutus*; the question might rather be of referring it to another genus than of confounding it with *Ech. acutus*. The most essential difference is that it has a primary tubercle on all the ambulacral plates. The globiferous pedicellariæ (Pl. XVIII. Figs. 2—3) have generally two lateral teeth on either side, the tridentate ones are somewhat shorter and broader than in the preceding species, but the edge is also here set with transverse series of small teeth. In some specimens only quite small tridentate pedicellariæ occur of a somewhat other form than the large ones (Pl. XX. Figs. 9, 19), but in other specimens both the small and the large form as well as all transitional sizes are found. Apical area, buccal membrane, and spicules as in *Ech. esculentus*. — The difference here stated between *Ech. elegans* and *acutus* is already seen from the description of Düben & Koren[1]), where it is said that »de primära knölarne bilda paa skalet, från anus till munnen, 20 ytterst tydliga, aldrig afbrutna rader», while it is said of *Ech. Flemingii* (p. 267): «de 10 rader primära knölar, som upptaga ambulacralplåtarne, äro esomoftast afbrutna»; this feature is also emphasized by the authors under *Ech. norvegicus*. To be sure it is not clearly seen in the Latin diagnoses, so that it is perhaps on account of the language that this feature has been overlooked by the later authors[2]) to great injury for the correctness of the determinations; especially *Ech. elegans* may often have been confounded with quite red specimens of *Ech. norvegicus*.

Ech. Wallisi Ag. In the description of this species (»Blake»-Echini. p. 39) it is said that it is »readily distinguished .... by the arrangement of the pairs of pores in sets of two». If this be correct it can scarcely be an *Echinus*, in which genus the pores are always trigeminate; Agassiz himself, however, thinks that it is »closely allied to, if not identical with, *Echinus Alexandri*», in which the pores are arranged in the common way. Agassiz further thinks it to be »allied to *E. Flemingii* and

1) Skandinaviens Echinodermer. p. 273.

2) Thus in Bell's »Catalogue of British Echinoderms» it is said of *Ech. acutus*: »each of these (the compound Ambulacra plates) has a large primary tubercle set about the middle of each plate». p. 146.

E. elegans»; according to what has been stated above it cannot be closely allied to both these species, and no inference can be drawn from the quite insufficient description that is not even accompanied by figures. From U. S. National Museum I have received a specimen on loan, determined as *Ech. Wallisi*. It is a large, fine specimen of *Ech. elegans* (only with somewhat shorter spines and higher than the typical form); but it is unfortunately not certain that it is really identical with *Ech. Wallisi*, as it does not agree very well with the description, except in the colour. Thus *Ech. Wallisi* must for the present remain somewhat problematic.

Most nearly related to *Echinus elegans* are the species: *gracilis*, *Alexandri*, and *lucidus*, and the new species described here: *Ech. affinis* n. sp. and *atlanticus* n. sp.; they have all of them a primary tubercle on every ambulacral plate; numerous fenestrated plates imbedded in the buccal membrane (this feature, however, not observed in *E. lucidus*); no ocular plates reach to the periproct; the spicules bihamate; all with rather strong, long, and pointed spines. *Ech. Alexandri* is rather sharply distinguished from the other species by its tridentate pedicellariæ, which are especially broad and comparatively short (Pl. XX. Fig. 1), while in the other species they are long and narrow (Pl. XVIII. Fig. 4). In the smaller forms of tridentate pedicellariæ the blade is more flat and broad, and the upper end of the apophysis is a little widened as a more or less perforated plate; in the larger forms there is some mesh-work in the bottom of the blade. As in *E. elegans* there are in these species all transitions between the largest and smallest tridentate pedicellariæ; to be sure, I have only seen a few of smaller size in *Ech. lucidus*, but as these resemble to a high degree, those of a corresponding size in the other species it may be supposed that also in this species large tridentate pedicellariæ will be found of the same form as in the other mentioned species. In all these species the tridentate pedicellariæ are upon the whole so similar, that reliable specific characters can scarcely be found in them (Pl. XVIII. Figs. 15, 21—22, 26—28). — The globiferous pedicellariæ in *Ech. Alexandri* have generally 3—4 teeth on either side, in the other species there are most frequently 1—1 or 1—2 lateral teeth. Also the globiferous pedicellariæ are very similar in all these species (Pl. XVIII. Figs. 9—11, 16—18, Pl. XIX. Fig. 18).

Ech. affinis is distinguished from the other species by the peculiar feature that the two series of tubercles in each ambulacral area are of unequal size or quite irregular; there is, however, always a primary tubercle on every ambulacral plate (see the particular description below). *Ech. gracilis* is easily distinguished from the other related species by its beautiful green coloration; the tridentate pedicellariæ (Pl. XVIII. Figs. 15, 21) are a little more serrate below than in the other species, it is however, scarcely a reliable character. Agassiz, in his description of it (Rev. of Ech. p. 293), says: this species holds an intermediate position between *E. Flemingii* Ball and *E. melo* Lamk., to both of which it is allied. This, according to what is stated here, is incorrect; its nearest relations are *E. elegans* and the other species named here. — *Ech. lucidus*, of which species Prof. Döderlein has kindly lent me a specimen for examination, is most similar to *Ech. Alexandri*, but may easily be distinguished from this species by its tridentate and globiferous pedicellariæ (Pl. XIX. Fig. 18).

In Challenger-Echinoidea (p. 114) Agassiz mentions *Echinus acutus* from st. 343, off Ascension, 425 fathoms. I have had occasion to examine these specimens in British Museum, and I must positively assert that it is not *Ech. acutus*. The test is high; the peristome very small (15^{mm} in a

specimen of a diameter of 65mm), the edge of the mouth not bent inward. There are very few spines on the abactinal side, almost only the primary ones, and as the plates are very high, the primary spines are also widely separated; on the actinal side there are more secondary spines, they are not, however, very close-set. The primary spines are of a middle length, and do not decrease much in length towards the apical area. A primary spine is found on each ambulacral plate, and they are of equal size in both series. The buccal membrane with numerous, lengthy, simple fenestrated plates outside the buccal plates; inside of these they are small and a little less perforated, as in *E. Alexandri*. The colour is beautifully red, the point of the spines white. The globiferous pedicellariæ (Pl. XVIII. Fig. 17), which are very few in number, have 1—1 lateral tooth, but are otherwise similar to those of *Ech. affinis*; also the tridentate pedicellariæ are scarcely to be distinguished from those of *E. affinis*. On the other hand the ophicephalous pedicellariæ are very characteristic, lengthy, and the teeth in the edge are uncommonly fine, only to be seen under especially high magnifying powers (Pl. XIX. Fig. 37). Triphyllous pedicellariæ of the common form; spicules bihamate. — There can be no doubt that this is a new species of *Echinus*, closely allied to *E. elegans*, *gracilis* etc.; I propose to call it **Echinus atlanticus**.

Presumably there are among the Echinids obtained by the «Challenger»-Expedition still one or two species allied to those mentioned here. Agassiz has determined these specimens partly as *Ech. elegans* (from Tristan d'Acunha), partly as *Ech. norvegicus* (from Patagonia, st. 308, and Japan, st. 232). That these determinations are incorrect is a sure fact. «*Ech. elegans*» from Tristan d'Acunha is a large form, very similar to *Ech. Alexandri*, that is to say, to the most long-spined specimens of this species (see the description below), but its tridentate pedicellariæ are narrow as in *Ech. affinis*. «*Ech. norvegicus*» from Japan is absolutely not this species; as far as I am able to see from my notes, it must be *Ech. lucidus*; the pedicellariæ are quite agreeing with those of that species. The specimens from Patagonia, at all events, are not *Ech. norvegicus*; they belong to two different species, of which one (3 large specimens) belongs to this group of species with a primary tubercle on all the ambulacral plates; perhaps it is *Ech. affinis*, but I am not able to determine it with certainty after my notes. The other species (4 small specimens) is *Ech. magellanicus* Phil. — The incorrect referring of these specimens to *Ech. norvegicus* has unfortunately given rise to the fact that this species is now constantly named among the «bipolar» animals.

Ech. margaritaceus Lamk. Of this species it is justly said in «Rev. of Ech.» (p. 493) that it has «very marked features», but in the description only one of its peculiarities is mentioned, viz. the nature of its covering with spines; «the plate is densely covered with minute secondary tubercles carrying short, slender, yellowish spines closely crowded together, which are a lower groundwork from which the primary spines, long, slender, and white, project prominently». This description of the spines is excellent, it is only to be added that these spinules are richly set with fine thorns, which gives them a peculiar silky gloss; further that the primary spines round the mouth are curved in the point, and that generally, but not always, some small, club-shaped spines are found on the buccal plates. Only every other ambulacral plate carries a primary tubercle. The apical area is very peculiar, all the ocular plates reach to the periproct, which is large and covered by numerous small plates among which the central plate is especially distinct. In small specimens all the ocular plates are shut off

from the periproct. The buccal membrane has inside of the buccal plates numerous small fenestrated plates imbedded in the skin; just outside of the buccal plates there are a few small plates, as thick and complicate as the buccal plates, and like these set with pedicellariæ. Nearest to these plates some small, fine fenestrated plates are found, but all the rest of the buccal membrane is quite naked. The globiferous pedicellariæ (Pl. XIX. Fig. 20) are of the same form as in *Ech. elegans* etc., but only one tooth is found on either side. The tridentate pedicellariæ are more peculiar and of a rather varying form (Pl. XIX. Figs. 3, 33). The blade is broad and deep, without or with a quite feeble net of meshes at the bottom; the edge is more or less sinuate in the part where the valves join: sometimes almost through the whole length (Fig. 3), sometimes only in the outer half (Fig. 33); it is finely serrate, but not thickened, and has no transverse series of teeth as in the *Echinus*-species mentioned above. The huge pedicellariæ.... covering the whole test , mentioned by Agassiz, are the globiferous pedicellariæ, which are rather long-stalked and conspicuous, not the tridentate ones. The ophicephalous and triphyllous pedicellariæ of the common form; it may, however be noted that in the latter the upper ends of the apophysis do not reach to the edge of the blade, and that there seems to be a tending to a formation of a little mesh-work in the blade. The stalks of the pedicellariæ of the common structure; the spicules bihamate, very numerous. — That this species is not most closely allied to *Ech. norvegicus*, as Agassiz thinks (14. p. 11) is clearly shown by the characters here mentioned.

The description of *Ech. margaritaceus* given here agrees remarkably well with the description of *Sterechinus antarticus* by Koehler (233. a.), and after having examined some specimens from Belgica which Prof. E. van Beneden has most kindly lent me, I must positively assert that it is *Ech. margaritaceus*; no single character can be pointed out that might be a mark of distinction between them. — *Echinus diadema* Studer is by Agassiz (Chall. Ech.), Bernard (79), and Meissner (285) thought to be synonymous with *Ech. margaritaceus*. Studer (386) admits, to be sure, that they are very similar, but thinks that some difference is found in the pedicellariæ — i. e. the ophicephalous ones. Now it is true that his figures show a slight difference; but the ophicephalous pedicellariæ are generally of very little importance with regard to the distinguishing between the species, and yield only quite exceptionally good specific characters (as in *Ech. atlanticus*). In this case there can be no question of distinguishing between the two species, either by the ophicephalous or the other pedicellariæ. After having examined some specimens, determined by Studer himself as *Ech. diadema*, which I have received for examination from the museum at Berlin, I must decidedly follow the mentioned authors; *Ech. diadema* cannot be distinguished from *Ech. margaritaceus*.

Echinus horridus A. Ag. is not closely allied to *Ech. norvegicus*, as stated by Agassiz (Chall. Ech. p. 116); its nearest relation is no doubt *Ech. margaritaceus*. The spines are quite as in this species, and also the pedicellariæ are very similar to those of the latter species. The tridentate pedicellariæ (Pl. XIX. Fig. 2) are rather much open and rather sinuate in the outer part, where the valves meet; they may become pretty large (a little more than 1^{mm}), and then they have a rather strong, coarse net of meshes in the blade (it may be described as cross-beams rather far from the bottom). In the globiferous pedicellariæ (Pl. XIX. Fig. 22) cross-beams are wanting between the edges of the blade (also in young *Ech. margaritaceus* they may be found without cross-beams), and there are

2—4 teeth on either side. The basal part has somewhat projecting outer corners. The ophicephalous pedicellariæ are of the common form, the triphyllous ones resemble those of *Ech. margaritaceus*. Agassiz says, but wrongly, that only two kinds of pedicellariæ are found in this species, one small-headed, long-stemmed, the other short-stemmed with a conical head. He gives, however, no figures of them. Unfortunately I can give no informations as to the peristome, as I forgot to examine it during my stay at British Museum. Neither can I tell whether the actinal primary spines are curved at the point. Primary spines are found on all the ambulacral plates; all the ocular plates are shut off from the periproct. The central plate little conspicuous. The spicules bihamate, numerous.

Echinus Neumayeri Meissner is also to be classed with these species, but is, however, rather sharply distinguished by several characters. In the description by Meissner (285) only the apical area is more thoroughly examined; as the type specimen has been sent me for closer examination, I am able to call attention to several other characteristic features of this species. A primary tubercle is only found in every other ambulacral plate. Unfortunately all the primary spines are broken, so that nothing can be said as to their length, or whether the actinal ones are curved at the point — what is probable. The secondary spines are rather coarse, not fine, silky, as in the two preceding species; they are, however, finely serrate. Three of the ocular plates reach to the periproct, as observed by Meissner; no conspicuous central plate is found. The apical area of the type specimen is, no doubt, abnormal, two of the genital plates being coalesced, and the adjoining one uncommonly broad; by this arrangement the two ocular plates at these genital plates are situated opposite to the latter, and not, as is elsewhere the case, opposite to the interspaces between them. (See the figure of Meissner. Op. cit. p. 12). The buccal membrane contains numerous small fenestrated plates inside of the buccal plates, outside of these it is almost naked, only with quite few, small fenestrated plates. Spines are found on the buccal plates. The globiferous pedicellariæ (Pl. XIX. Fig. 14) recall those of *Ech. horridus* very much, but the outer corners of the basal part are somewhat more conspicuous, and the edges of the blade are connected by cross-beams; there are 1—1 or 1—2 lateral teeth. The tridentate pedicellariæ (Pl. XX. Fig. 11) resemble those of *Ech. margaritaceus*, as is also the case with the triphyllous ones (Pl. XX. Fig. 7); the ophicephalous ones of the common form. The spicules bihamate, very few; I have only seen a few in the buccal membrane, none in the tube feet.

Echinus magellanicus Phil. To the descriptions of this species by Philippi and Agassiz the following informations must be added. A primary tubercle is found on all the ambulacral plates; the actinal primary spines are curved at the point, the secondary spines are coarse as in *Ech. Neumayeri* and almost smooth. The buccal membrane is quite naked both inside and outside of the buccal plates, and no spines seem to be found on these. The periproct is small, covered by a few, rather large plates, without distinct central plate; generally one ocular plate reaches to the periproct, as observed by Agassiz. The globiferous pedicellariæ (Pl. XIX. Fig. 23) chiefly as in *Ech. margaritaceus*, with 1—2 teeth on either side. The tridentate pedicellariæ (Pl. XIX. Figs. 11, 17), which are (always?) very small, 0·5^{mm}, are rather different from those of the other species; in the outer part where the valves join, the edge is finely serrate, in the lower part it is smooth, but rather thick; no net of meshes at the bottom. The valves are apart for a rather long space, but the slit between them is quite narrow. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules bihamate, numerous.

In Challenger-Echinoidea p. 116 *Ech. magellanicus* is mentioned from Prince Edward Island and Crozet Islands, from the latter place at a depth of 1600 fathoms (st. 147). I can assert positively that the latter is not *Ech. magellanicus*; its globiferous pedicellariæ are of quite another form than in this species. I suppose it to be a new species allied to *Ech. Neumayeri* and the other species belonging here, but as I have not a sufficient material of pedicellariæ of it, nor sufficient notes of it, I must restrict myself to show that it is no *Ech. magellanicus*. I also take it to be doubtful whether the specimens from Prince Edward Island are *Ech. magellanicus*; at all events they will have to be examined more thoroughly with regard to the characters mentioned here. That this species is found at Australia and New-Zealand I must also regard as doubtful, until renewed, thorough examinations have confirmed these statements. To be sure, Farquhar (144) enumerates *Ech. magellanicus* among the Echinids of New-Zealand, but it may, perhaps, be *Ech. albocinctus*, which, in a communication from Prof. Hutton, is said to be the same species. That this statement is incorrect will be shown hereafter. Perhaps also *Ech. darnleyensis* may be hidden among the Australian Echinids referred to *Ech. magellanicus*, as has been supposed by Woods (442. p. 165). For the present *Ech. magellanicus* is only known with certainty from the coasts of Patagonia and the adjoining seas. — Some small specimens from Chall. st. 308 (Patagonia), by Agassiz referred to *Ech. norvegicus*, are *magellanicus*.

Echinus albocinctus Hutton. A specimen of an *Echinus*-species from New-Zealand which from earlier times is found in the museum of Copenhagen, must, no doubt, be referred to this species, as it agrees exactly with the description. The description by Hutton, however, is far from being exhaustive — what may be applied to almost all descriptions of Echinids — and so some informations of this species are given here. — A primary tubercle is found on all the ambulacral plates; the actinal spines are not curved at the point, the small spines rather thick, almost smooth. One of the ocular plates reaches almost quite to the periproct which is small, and (as far as can be seen) covered by few, rather large plates without central plate. The buccal membrane is quite naked, with the exception of the buccal plates; whether spines are found on these cannot be decided. The globiferous pedicellariæ (Pl. XIX. Fig. 19) have only one unpaired lateral tooth; the basal part is very varying in form, sometimes with strongly projecting outer corners, sometimes rounded — or rounded on one side, projecting on the other. The tridentate pedicellariæ (Pl. XIX. Fig. 25) are most similar to those of *E. magellanicus*, but the edge is a little serrate, not thick and smooth where the valves are open; in the little space at the point where the valves meet, the edge is finely serrate. Below the articular surface there is a peculiar arc reminding of that of the ophicephalous pedicellariæ; also in other Echinids an indication of such an arc may be found. The ophicephalous and tridentate pedicellariæ of the common form. The spicules bihamate, they seem to be rather few. — That this species is well distinguished from *Ech. magellanicus* is evident from the informations given here. — *Echinus elevatus* Hutton, according to an information received from Prof. Hutton, is synonymous with *Amblypneustes formosus*.

Echinus fasciatus Parfitt (311), no doubt, is only a young specimen of one of the Echinids occurring at the coasts of England, but to which of these it may belong, it is impossible to see from the description — it may be applied to each and all of them, from *Strongyloc. drobachiensis* to *Ech. miliaris*. Philippi (323) enumerates the species *Echinus Cunninghami*, *lepidus*, and *rodula* without

giving any information whatever of them; as far as I can see they are nomina nuda, and Philippi deserves no praise for having introduced them.

Echinus multicolor Yoshiwara I have not seen; the description gives no information of pedicellariæ, spicules, and several other important features, so that nothing can be said with regard to its being a genuine *Echinus* or not.

The species *Ech. miliaris*, *microtuberculatus*, *angulosus*, *verruculatus*, *Robillardi*, and *darnleyensis* are no genuine *Echinus*-species. For the present then they may be left out of consideration, while the question of the grouping of the species above mentioned is treated.

Do all these species really belong to the same genus, or can there be any question of grouping them into more genera? The question is partly answered already, Koehler having established the genus *Stereechinus* on *E. margaritaceus* (without knowing, to be sure, that it was this species). The characters upon which the genus is based, are: the comparatively large central plate, the narrow apical plates, of which all the ocular plates reach to the periproct, and the comparatively great height of the coronal plates. — The character of the apical plates is evidently useless, all the ocular plates being shut off from the periproct in smaller specimens. Also the central plate seems to me to be an only little valuable character; in every young *Echinus* the central plate is distinct, it does not disappear till a later stage, other small plates being formed round it, so that at last it cannot be distinguished from the secondary plates. Neither seems the height of the coronal plates to be a valuable character, as it varies much according to the size of the animal. — Now it is not my meaning to say that the genus *Stereechinus* cannot be kept up, only that the characters upon which it is based, cannot be used; we must seek other characters for it. May, then, other characters be found by which to group the species?

Among the characters mentioned above one is found that might beforehand be thought to be of great importance, viz. whether a primary tubercle is found on every or only on every other ambulacral plate. In the species *esculentus*, *acutus*, *melo*, *margaritaceus*, and *Neumayeri* a primary tubercle is only found on every other ambulacral plate, in all the other species it is found on every ambulacral plate. That this feature, however, can be of no primary importance is evident from the fact that it separates *Ech. margaritaceus* and *horridus*, two species that are, no doubt, very closely allied. — Another character of undoubtful value is whether the buccal membrane contains numerous fenestrated plates, or is quite (or almost) naked, at all events outside of the buccal plates. Numerous plates in the buccal membrane are found in the species: *esculentus*, *acutus*, *melo*, *elegans*, *gracilis*, *Alexandri*, *affinis*, *atlanticus*, and *lucidus* (not examined); naked buccal membrane is found in the species: *margaritaceus*, *horridus* (not examined), *Neumayeri*, *magellanicus*, and *albocinctus*. This character does not separate allied species, but divides them into two groups which seem to be well divided as to habitus, but where the species of each group seem to be mutually rather closely allied. It is evident then that we have here a specially important systematic character. Another feature gives quite the same grouping of the species, viz. whether the edge of the tridentate pedicellariæ is thick and provided with numerous small teeth arranged in more or less regular transverse series, or it is thin and simply serrate. In the former group, *Ech. esculentus* etc., the edge is thick with transverse series of small teeth, in the latter group, *Ech. margaritaceus* etc., it is simply serrate. This character, however, is not quite

reliable, as the small tridentate pedicellariæ in the former group have also a simply serrate edge. Other characters giving the same natural grouping of the species, do not seem to be found.

The former group may be subdivided according to the ambulacral plates, the species *esculentus*, *acutus*, and *melo* having only a primary spine on every other ambulacral plate, while the species *elegans*, *gracilis*, *Alexandri*, *affinis*, *atlanticus*, and *lucidus* have a primary spine on every ambulacral plate. Thus this group might be subdivided into two genera according to this character. This division, however, I do not think good; *Ech. esculentus* differs so much from *acutus* and *melo*, that it seems to be incongruous to class it with these two species contrary to the other species of the group; in quite young specimens of *Ech. acutus* a primary spine is often found on all the ambulacral plates, which also tells against using this feature as a generic character. Finally it is also seen in the other group that neither there a natural division can be obtained by means of this character. Thus it seems to be correct to regard this whole group as one genus keeping the name of *Echinus*. The feature of the ambulacral plates may here be used practically by the determination of the species.

The other group, the species *margaritaceus*, *Neumayeri*, *horridus*, *magellanicus*, and *albocinctus*, shows a series of striking peculiarities, so that the question naturally arises, whether all these species are to be referred to one genus. The characters by which a subdivision might be made, are, whether every ambulacral plate or only every other plate has a primary spine, whether the secondary spines are fine, silky, or not, whether or not the actinal spines are curved in the point, whether the buccal membrane is quite naked, or fenestrated plates are found inside of the buccal plates; finally the question might also be of using the pedicellariæ or the features of the ocular plates as a basis of the distribution of the species.

E. albocinctus is the most isolated one, especially distinguished by having only one unpaired lateral tooth on the globiferous pedicellariæ. As this feature, as will be shown below, is of very great systematic importance, it seems reasonable to separate this species as a separate genus, even if in some features it agrees very exactly with *Ech. magellanicus* (the quite naked buccal membrane, primary tubercle on every ambulacral plate). For this form the name of **Pseudechinus** is proposed. — To separate the other four species is scarcely correct; according as one or other of the mentioned characters is used as a base of the division we get a different grouping. Here a so curious intermingling of all characters is found, that we only seem to have two chances left: to establish each species as a separate genus — by which nothing is gained — or to unite them all to one genus, which latter I think to be the most correct thing. Then this genus gets the name of *Sterechinus* Koehler. Considering the common opinion of the difficulty of these species I shall give the following

Table of the Sterechinus-species[1]).

1. The secondary spines fine, silky ..... 2.
   — — — coarse ..... 3.
2. Primary tubercle only on every other ambulacral plate; the globiferous pedicellariæ with 1—1 lateral tooth, the edges connected by cross-beams ..... *St. margaritaceus.*

[1]) A table of the *Echinus*-species will be given below, after the description of the northern species.

Primary tubercle on every ambulacral plate; the globiferous pedicellariæ with 2—4 teeth on either side, the edges not connected ..... *St. horridus.*

3. Primary tubercle on every other ambulacral plate ..... *St. Neumayeri.*

— — — — ambulacral plate ..... *St. magellanicus.*

Echinus miliaris, *microtuberculatus*, and *angulosus* form a separate group chiefly characterized by the globiferous pedicellariæ (Pl. XVII. Figs. 1, 7). The blade is rather flat, comparatively broad, and passes evenly into the basal part; no cross-beams connect the edges across the inside of the blade; the edges are not thickened, and project into more or fewer teeth on either side. There is no neck; the stalk as usually constructed of long threads connected by cross-beams. A somewhat similar form of globiferous pedicellariæ is found in *Strechinus horridus* (Pl. XIX. Fig. 22), and sometimes also in *Echinus Alexandri* (Pl. XVIII. Fig. 9). A comparison of the figures will show, however, that they are very different, even if it is not easy to point out a particular distinguishing character; the most significant one is, I think, that here the edge is somewhat thickened, so that the teeth are placed on it, while in *Ech. miliaris* etc. the edge is quite sharp, and the «teeth» are simply indentations in the edge; also the whole form is somewhat different, as shown by the figures.

The following characters of the separate species must be pointed out. In *Ech. miliaris* the buccal membrane is covered by large, thick fenestrated plates. The globiferous pedicellariæ have numerous lateral teeth; the tridentate ones have a rather strong net of meshes in the bottom of the blade (only the large ones); the edge is coarsely indented below, in the outer part where the valves join coarsely sinuate, but the sinuations are again finely serrate; the small teeth form no transverse series (Pl. XVII. Fig. 11). The ophicephalous and triphyllous pedicellariæ with no conspicuous peculiarities. — All three species have a primary spine on every ambulacral plate; in *miliaris* and *microtuberculatus* the ocular plates are shut off from the periproct, in *E. angulosus* the two (three) reach to the periproct; no distinct central plate.

Ech. microtuberculatus agrees exactly with *miliaris* in the structure of the pedicellariæ; it is only to be observed that the tridentate pedicellariæ have rather distinct transverse series of teeth on the edge. The plates of the buccal membrane are especially characteristic (Pl. XVI. Fig. 14). They are large, thick, greenish, and of quite another structure than in *miliaris*, not consisting of the usual reticulation, but of a homogeneous mass of lime, in which the pores appear as deep, funnel-shaped holes. Also the plates inside of the buccal plates are constructed in this way. Otherwise it is distinguished from *miliaris* by its somewhat finer spines and corresponding smaller tubercles (Pl. XV. Figs. 8, 9); the colour of the test and spines is more intensely green. — In the original diagnosis of *Ech. microtuberculatus*[1]) it is said: «ambulacres à denticules très-arquées et composées de six paires de pores»; in Blainville's «Manuel d'Actinologie» 1834 p. 228 *E. parvituberculatus*, de Blainv. «Dict. tom. 37. p. 88, sous le nom d'*E. microtuberculatus*» is enumerated under the division D. «Espèces régulières, de forme un peu variable; les denticules des lignes ambulacraires droites ou arquées de cinq paires de pores au moins». Accordingly it is no doubt wrong when Agassiz and Desor (Catalogue raisonné des Echinides p. 64) enumerates it (referring to the passages quoted above) under their fourth type,

[1]) Dictionnaire des Sciences naturelles. T. XXXVII. p. 88. (1825.)

with trois paires de pores obliques». Now if the two authors had done so consciously, they would certainly have made a remark to the effect that the type specimen had not the six pairs of pores, but only three. Such a remark, as far as I can see, they have not made, and so there can scarcely be any doubt that this species has quite wrongly got the name of *microtuberculatus*. As a synonym of it Agassiz & Desor (loc. cit.) mention *Ech. pulchellus* Ag. and *decoratus* Ag., and the former of these names should then be employed for this species. The description of *Ech. pulchellus*[1]) may agree rather well with it, even if it cannot be said to be a very appropriate one; it might also agree with young specimens of *Strongyloc. lividus*. Therefore I think it better to wait for a renewed examination of the type specimens, before the commonly used name of *microtuberculatus* is rejected.

Ech. angulosus is distinguished from the two other species by the two ocular plates reaching to the periproct, and by the plates of the buccal membrane being fine and quite imbedded in the skin; only a few are thick and carry pedicellariæ. The globiferous pedicellariæ have only two, more rarely three teeth on either side; the tridentate ones are more strongly sinuate in the outer part where the valves join (Pl. XVII. Fig. 6); the larger ones have a rather strong net of meshes, the edge is thick, in the lower part with very distinct transverse series of small teeth. The ophicephalous pedicellariæ have generally only a simple keel in the middle of the blade, without any net of meshes (Pl. XVII. Fig. 3).

These three species must absolutely form a separate genus. Most recent authors use the name of *Psammechinus* Ag. for them, but wrongly. In Catalogue raisonné p. 64 under the fourth type Sous-genre *Psammechinus* Ag.» are named first the species *varicgatus* Lamk. and *scmituberculatus* Val. and as no. 3 *subangulosus* Lamk. There can be no doubt, then, that the two first-named may claim the name of *Psammechinus*, as it appears that they cannot be classed with the genus *Toxopneustes*, to which they are referred in Rev. of Ech., but must form a separate genus (see below). For the species *miliaris*, *microtuberculatus*, and *angulosus* a new genus must then be established; I propose the name of **Parechinus**.

Psammechinus verruculatus Ltk. Agassiz (Rev. of Ech. p. 122) mentions this species as synonymous with *Parech. angulosus*; de Loriol (245. p. 21) objects to this and maintains that they are two well distinguished species. I must not only grant that de Loriol is right in his statement, but shall have to go much farther and assert that it cannot be referred to the same genus, nay, not even to the same family as *Parech. angulosus*. Prof. de Loriol has kindly sent me a specimen of his *Echinus verruculatus* Ltk. from Mauritius, and so I have been able to compare it with the type specimens of Lütken, which are found in the museum of Copenhagen. All the type specimens are naked tests, so that it is impossible to tell quite certainly, whether the species of de Loriol is really identical with these specimens; all the most important characters are wanting on the naked tests — nay, it is, moreover, probable that the type specimens really belong to two different species. It is, however, certain, that the description given by de Loriol of the coloration of his specimens[2]), agrees exactly with two of the type specimens, and I think it very likely that they are really identical. Full

[1]) Introduction to Valentin's Anatomie du genre Echinus. p. VI.

[2]) In the specimen sent me by de Loriol, there is no trace of coloration on the test; only the spines have the colour described by de Loriol.

certainty, I think, can never be obtained, and there is nothing to be done but to resolve that the species of de Loriol shall in future be taken to be the *Psammechinus verruculatus* of Lütken.

To the description by de Loriol I shall here make some additions. A primary tubercle is found on every ambulacral plate. De Loriol states that two ocular plates reach to the periproct; in the specimen before me this is only the case with one plate. The genital pores are especially large. The buccal membrane contains numerous small fenestrated plates both inside and outside of the buccal plates; those outside the buccal plates are a little larger, a few are thick and carry pedicellariæ, while most of them are simple fenestrated plates, quite imbedded in the skin; a few bihamate spicules are also found in the buccal membrane. The gills contain the usual fenestrated plates. The mouth-slits, as observed by de Loriol, are small, but very distinct. The globiferous pedicellariæ are very different from those of the genera *Echinus*, *Strerechinus*, and *Parechinus*; by this reason only this species was to be separated from those genera. The blade is quite closed to a thin tube without lateral teeth, as in *Sphærechinus granularis*; no neck; I suppose that glands are found on the stalk, but this fact could not with certainty be substantiated from the dried specimen in hand. The tridentate pedicellariæ (Pl. XXI. Fig. 2) have a broad, deep blade with a slight indication of a net of meshes in the bottom; the valves join for almost their whole length, the edge is rather strongly, but simply serrate. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules are very peculiar (Pl. XXI. Fig. 28), small, with a little ball at each end, quite resembling dumb-bells. They are found in especially great numbers in the globiferous pedicellariæ, also, however, in the tube feet, but in rather small number. Genuine bihamate spicules do not appear to be found in the tube feet.

This peculiar form of globiferous pedicellariæ and spicules is also found in *Echinus Robillardi*, and *darnleyensis*, further in the genera *Toxopneustes* and *Tripneustes*, and there can be no doubt that the mentioned species belong here. To which genus they will have to be referred cannot be decided, until we have examined the *Toxopneustes*- and *Tripneustes*-species.

Echinus Robillardi Loriol. To the description of this species by de Loriol (245 p. 23) I may add the following informations (a specimen received from Prof. de Loriol). A primary tubercle is found on every ambulacral plate. The peristome is very peculiar, quite naked. Inside of the buccal plates a belt is found with numerous bihamate spicules, and in the inner edge a few larger, irregular needles are found (Pl. XXI. Fig. 24. b). At the outer edge of the peristome again rather numerous bihamate spicules are found, and in the gills seem to be found, not the usual fenestrated plates, but numerous bihamate spicules. Otherwise no other plates than the buccal ones are found in the buccal membrane; these buccal plates are not placed in pairs opposite to each other as usual, but one outside the other; neither spines nor pedicellariæ are found on the buccal plates. The very peculiar, oblique apical area has been accurately described by de Loriol, who also points out that the slits of the test are small and indistinct. The globiferous pedicellariæ as in *Sphærechinus*, without lateral teeth, the blade a closed tube; I have not been able to decide from the dried specimen in hand whether glands are found on the stalk. The tridentate pedicellariæ very peculiar (Pl. XXI. Figs. 4, 11); the lower part of the blade is narrow and quite filled by a net of meshes, so that the edges are quite coalesced; the upper part is a little widened with straight, finely serrate edge. Only this part of the valves join, so that they are wide apart below. The ophicephalous pedicellariæ without conspicuous

peculiarities; triphyllous pedicellariæ I have not seen. In the globiferous pedicellariæ numerous spicules are found, somewhat thickened in the ends (Pl. XXI. Fig. 24. a), although not markedly dumb-bell-shaped; also a few common bihamate spicules are found among them. In the tube feet the bihamate spicules are predominant, but the other form is also found. — De Loriol, no doubt, is right that this is a distinct species; but it is no *Echinus*. Its nearest relations are «*Echinus*» *verruculatus* and especially *darnleyensis*.

Echinus darnleyensis Woods. Of this species I have had occasion to examine a specimen from Thursday Island, Torres Strait, 4 fathoms (the «Alert»-Expedition) in British Museum. (I cannot answer for the correctness of the determination; that it corresponds with the description is no guarantee for its being the same species, as the description gives only the usual things: spines, tubercles etc., but mentions neither spicules nor pedicellariæ.) A primary tubercle is found on every ambulacral plate; according to Woods (442. p. 165) the ocular plates are quite shut off from the periproct — but according to an information from Prof. Bell they are not shut off from the periproct in these specimens (I have forgotten to ascertain it myself). The buccal membrane is quite naked with the exception of the buccal plates which are placed in pairs opposite to each other, and carry a few pedicellariæ. «With ten rounded small openings surrounded by Pedicellariæ», it is said in the description by Woods; this, I think, must be the holes in the buccal plates for the buccal tube feet — a rather common feature to note in a description of species! Innermost in the edge of the mouth numerous needle-shaped, more or less irregular spicules are found resembling those of «*Ech. Robillardi*; they are arranged parallel to the edge of the mouth; a few are a little fenestrated. Outside of these some bihamate spicules are found, but far from so great a number as in *Robillardi*. Near the gills numerous bihamate spicules are found in the buccal membrane. The gills themselves contain the common irregular fenestrated plates. According to Woods the auriculæ are only «slight thin processes, which do not meet»; Prof. Bell informs me that they are here of the common form. (In *verruculatus* and *Robillardi* they are also of the common form.) The globiferous pedicellariæ as in *Sphærechinus*, only is the blade uncommonly short (Pl. XXI. Fig. 36). In the tridentate pedicellariæ (Pl. XXI. Fig. 7) the blade is broad, open, with only a slight net of meshes in the bottom. The edge is finely, simply serrate in the outer part where the valves join; in the lower part a few larger indentations are found. The valves are rather wide apart. Ophicephalous and triphyllous pedicellariæ of the common form. The spicules (Pl. XXI. Fig. 23) of the globiferous pedicellariæ arcuate, but not pointed at the ends; in the tube feet only a few bihamate spicules are found. — Woods thinks that it is this species Agassiz has wrongly referred to *Ech. magellanicus*; that it has nothing to do with *magellanicus* is certain, although the differences pointed out by Woods: «in the actinostome being larger; in the abactinal system, where the genital plates have only two tubercles, and in the color of spines and test» are quite irrelevant. The principal difference is to be found in the globiferous pedicellariæ and the spicules; they show that this species is no *Echinus* or *Sterechinus* at all, but like *Ech. Robillardi* and *verruculatus* is closely allied to *Toxopneustes* and *Tripneustes*.

To the genus *Toxopneustes* Ag. are referred the species: *maculatus* (Lamk.), *pileolus* (Lamk.), *elegans* Döderl., *variegatus* (Lamk.), and *semituberculatus* (Val.); to the genus *Tripneustes* Ag. (in Rev. of Ech. this genus is called *Hipponoë*) are referred the species: *esculentus* (Leske), *depressus* Ag., and

variegatus (Leske). I have had occasion to examine all these species, with the exception of *T. maculatus*; of *T. elegans* Prof. Döderlein has most kindly sent me a specimen, *T. semituberculatus* I have seen in British Museum, the other species are found in the museum in Copenhagen. I shall therefore make a few supplementary remarks to the existing descriptions of these species. Information is especially wanting with regard to pedicellariæ and spicules.

Toxopneustes pilcolus (Lamk.). Some specimens found in our museum have by Lütken been determined as *T. maculatus*, but this determination, no doubt, is incorrect. They agree exactly with the description of *T. pilcolus*, having especially the characteristic coloration so often mentioned; on the other hand they do not at all agree with Lamarck's diagnosis of *E. maculatus*. Therefore I do not hesitate to refer them to *pilcolus*. — Only every other ambulacral plate has a primary tubercle; two ocular plates reach to the periproct. The buccal membrane contains numerous fenestrated plates as well inside as outside of the buccal plates; not a few of them are thick and carry pedicellariæ. Besides the fenestrated plates the buccal membrane contains numerous bihamate spicules; also in the gills bihamate spicules are found in great numbers together with the common irregular fenestrated plates. No spines on the buccal plates. The globiferous pedicellariæ without lateral teeth and with tubular blade as in *Sphærechinus*, but they are remarkable by the extraordinary length of the blade and the end-tooth (Pl. XXI. Fig. 13); in the apophysis there is a long, narrow slit; no neck; small glands are found on the stalk. The tridentate pedicellariæ are very large, the head up to a length of 3^{mm}; the neck very short. The outer part of the blade where the valves join, is coarsely and irregularly indented in the edge, in the lower part the edge is smooth, or has a few larger thorns. In the bottom of the blade a strong and very complicate net of meshes is found hiding the usual regular arrangement of the holes, even at the point of the blade (Pl. XXI. Fig. 41). In smaller pedicellariæ this net of meshes, no doubt, will be much less developed, but such pedicellariæ I have not found in the specimens in hand. For a long way the valves are apart, but not much, so that only a narrow slit is found between them. Ophicephalous and triphyllous pedicellariæ without particular peculiarities. The stalk of the pedicellariæ compact. The spicules (Pl. XXI. Fig. 21. a) in the pedicellariæ are of the typical dumb-bell shape; in the smaller globiferous pedicellariæ on the abactinal side they form a thick white border all round the head, the valves being united almost through their whole length by a fine skin. These pedicellariæ are almost always open, and give the animal a very characteristic appearance — which, no doubt, also holds good with regard to *T. elegans*. When they are shut the border of spicules is slackened to as to make a kind of fringe round the point; the large globiferous pedicellariæ of the actinal side do not seem to have such a border. In the tube feet a few dumb-bell-shaped spicules are found together with more numerous bihamate spicules; most of the latter, especially those nearest to the sucking disk, have some small branches on the outside at the points (Fig. 21. b); the spicules of the buccal membrane are much finer (Fig. 21. c); also here a few dumb-bell-shaped spicules are found.

As a synonym of *T. pilcolus* Agassiz in Rev. of Ech. mentions the species *Boletia rosea* before established by himself. To judge from the authentic specimens before me of *B. rosea* (from Mus. Comp. Zool.) I think it, however, somewhat doubtful that they are really only one species. Besides the difference with regard to colour (the spines uniformly brown, the test only with a slight reddish tint,

otherwise quite brown), there is another fact that may, perhaps, be of some significance. In *T. pileolus* the secondary tubercles in the ambulacral areas — on the plates wanting the primary tubercle — are as large as the primary ones, so that it can only be seen from their position, whether they are primary or secondary ones; in *roseus* the primary tubercles are distinctly larger than the secondary ones on the plates where the primary tubercle is wanting. If this feature proves to be constant, there can scarcely be any doubt that they are two well distinguished species. In spicules and pedicellariæ any difference of importance is scarcely to be found.

Toxopneustes elegans Döderl. agrees exactly with *T. pileolus* (I have not, however, seen the tridentate and triphyllous pedicellariæ); as far as I can see it is only distinguished from *T. pileolus* by its peculiarly coloured spines — they have a sharply limited dark band near the point — and by the colour of the test, it being in *T. elegans* »yellowish without any indication of coloration, only the median suture of the ambulacral and interambulacral areas is dark violet on the apical side». (Döderlein 114. p. 99.)

Toxopneustes variegatus (Lamk.). To the existing descriptions I shall add the following remarks. A primary tubercle is found on all the ambulacral plates. The globiferous pedicellariæ (Pl. XXI. Figs. 38, 40) with tubular blade, without lateral teeth, not very much lengthened. Glands may be found on the stalk, but are most frequently wanting. The tridentate pedicellariæ (Pl. XXI. Fig. 10) are large, the head up to 1·5^{mm}, and long-necked. There is only little mesh-work in the blade, the edge is straight, rather thick, with numerous, irregularly placed small teeth; the valves are only a little apart below. The triphyllous and ophicephalous pedicellariæ of the common form. The spicules (Pl. XX. Fig. 15) are dumb-bell-shaped, exceedingly numerous in the skin of the globiferous pedicellariæ (as in all these species); here all transitional forms may be found from small, oval bodies to typical, bihamate spicules (Pl. XXI. Fig. 31), but the really dumb-bell-shaped ones are by far the most numerous. In the tube feet only bihamate spicules are found in small number.

Toxopneustes semituberculatus (Val.), no doubt, is most nearly allied to *T. variegatus*; especially must be emphasized that it likewise has a primary tubercle on all the ambulacral plates. Spicules and pedicellariæ as in *T. variegatus*, only the globiferous pedicellariæ show a conspicuous peculiarity the lime in the valves being of a deep violet colour, with the exception of a small, oblong, clear spot in the basal part on either side of the apophysis. Glands are found on the stalk. — Otherwise, as is well known, it is distinguished from *variegatus* by the less marked plate-covering on the buccal membrane.

Tripneustes esculentus (Leske). A primary tubercle is only found on every third or fourth ambulacral plate. The buccal membrane contains numerous small fenestrated plates inside of the buccal plates, outside of these fewer, small, round, thick plates with pedicellariæ are found. The pedicellariæ are numerous, much pigmented, and form a quite black ground between the spines. The globiferous pedicellariæ are small, the valves as in the other allied forms (Pl. XXI. Fig. 39). Glands are found on the stalk. In the tridentate pedicellariæ (Pl. XXI. Fig. 16) the blade is filled by a highly developed net of meshes; the point rather abruptly widened with the edge exceedingly finely serrate, in the lower part of the blade the edge is more or less coarsely dentate. The valves are rather wide apart, only joining at the point. Together with these a smaller form of tridentate pedicellariæ

(Pl. XXI. Fig. 3) is found, with a broader blade and less developed mesh-work; the part where the valves join, is comparatively larger than in the large form; transitional forms are found. The ophicephalous pedicellariæ shorter and broader than usual (Pl. XXI. Fig. 22); the triphyllous pedicellariæ of the common form. The spicules of the pedicellariæ are typically dumb-bell-shaped (Pl. XXI. Fig. 33. a); in the tube feet common bihamate spicules are found together with very small spicules, also bihamate (Fig. 33. b) or a little dumb-bell-shaped; in the buccal membrane numerous small spicules are found with truncate ends (Fig. 33. c) together with larger bihamate spicules (Fig. 33. d).

Tripneustes depressus A. Ag. is, with regard to spicules and pedicellariæ, quite similar to *esculentus*; I have not, however, been able to find tridentate and triphyllous pedicellariæ on the only, badly preserved specimen before me. As in *esculentus* only every third or fourth ambulacral plate has a primary tubercle. The difference between the two species is very well given in Rev. of Ech.

Tripneustes variegatus (Leske). A primary tubercle is only found on every third ambulacral plate; the secondary tubercles almost as large as the primary ones, so that the latter are only to be distinguished with difficulty, while in *esculentus* the primary tubercles form a beautiful, rather conspicuous series. As in *esculentus* two ocular plates reach to the periproct; no central plate. The buccal membrane with numerous thick fenestrated plates carrying pedicellariæ; even globiferous pedicellariæ may be found on the buccal membrane, a fact I have not seen in any other Echinid. The globiferous pedicellariæ quite as in *esculentus*, the tridentate ones resemble very much the smaller form in *esculentus*; a form corresponding to the larger form in this species I have not found in *T. variegatus*. Ophicephalous and triphyllous pedicellariæ as in *esculentus*; the spicules of the pedicellariæ typically dumb-bell-shaped; in the tube feet only really dumb-bell-shaped spicules seem to be found, in the buccal membrane there are comparatively few spicules, partly larger, bihamate ones, partly smaller, somewhat dumb-bell-shaped ones. According to Lovén (252) this species corresponds to Linné's *Echinus Gratilla*; this name must then be adopted instead of *variegatus* (Leske).

According to the definition given by Agassiz (Rev. of Ech. p. 297 seq.) the genera *Toxopneustes* and *Tripneustes* (*Hipponoë*) are chiefly distinguished by the fact that in *Toxopneustes* the pores are arranged in oblique arcs of three pairs, while in *Tripneustes* the pores form three vertical series; the series in the middle is irregular, the two outer ones are regular. The other characters — whether the peristome is large or small, and whether the tubercles form more or less regular vertical and horizontal series — are of a so relative nature, that it will be better to leave them out of consideration. Unfortunately the mentioned principal character is not reliable either; in larger specimens of *Toxopneustes* the pores may form three irregular longitudinal series as in *Tripneustes*, what has already been mentioned by Agassiz in his diagnosis of the genus *Toxopneustes*, and in smaller specimens of *Tripneustes*, up to a diameter of ca. 20^{mm}, the pores are arranged in quite similar arcs of three pairs as in *Toxopneustes* without any indication of an arrangement in longitudinal series. Accordingly none of the characters hitherto pointed out are reliable. It must, however, be admitted that the species *esculentus*, *depressus*, and *gratilla* form a group that is, as to their habitus, very different from the species referred to *Toxopneustes*, so that it seems natural to keep them as a separate genus. To this is to be added that, if the genera *Toxopneustes* and *Tripneustes* were to be united, it would give rise to a complete rearrangement of the nomenclature; especially the name of *Toxopneustes* would then have

to be used for a quite different series of forms: *Strongylocentrotus tuberculatus* etc., which, as will be shown below, do not at all belong to the genus *Strongylocentrotus*. This would certainly create much confusion, and only to avoid this calamity these genera ought to be kept up, if there are no cogent reasons for uniting them. Now such reasons are not found; on the contrary a closer examination shows that other characters are found, more reliable than those given by Agassiz, which characters may also be used for the small specimens, where the characters mentioned above cannot be used at all.

While all the species referred to *Tripneustes* are no doubt closely allied, the same thing cannot be said of the *Toxopneustes*-species; they form two well distinguished groups. The species *pileolus*, *elegans*, and *roseus* form a group characterized by having only a primary tubercle on every other ambulacral plate, by the peculiar globiferous pedicellariæ with a border of spicules and much lengthened blade and end-tooth, and by the branched bihamate spicules in the tube feet. The species *variegatus* and *semituberculatus* have a primary tubercle on all the ambulacral plates; the globiferous pedicellariæ have no border of spicules, the blade is not much lengthened, the bihamate spicules in the tube feet are not branched in the ends. That the buccal membrane is more richly provided with plates and the spines longer than in the former group, I take to be less reliable characters, especially as there is a rather great difference between *variegatus* and *semituberculatus* with regard to the plates of the buccal membrane. Thus the two groups are seen to be very well distinguished, and each of them ought no doubt to form a separate genus. As *pileolus* is the type of the genus *Toxopneustes*[1]) of Agassiz, this group must keep this name. The other group gets the name of *Psammechinus*, which name here gets its definitive place, after having so long been abused (comp. p. 108); the numerous names that in the course of time have been applied to *Ps. variegatus*: *Lytechinus*, *Psilechinus* etc., become only synonyms of *Psammechinus*.

After having thus limited the genus *Toxopneustes*, it is easy to state the characters, by which the genus *Tripneustes* is distinguished as well from the former genus as from *Psammechinus*. A primary tubercle is only found on every third ambulacral plate; no border of spicules on the globiferous pedicellariæ, the blade not much lengthened; the bihamate spicules in the tube feet not branched in the ends. To these characters is then to be added with regard to the larger specimens the characteristic arrangement of the pores in three separated longitudinal series. — In «Rev. of Ech.» Agassiz has adopted the name of *Hipponoë* Gray in stead of *Tripneustes* Ag. Bell (38) maintains that this is unwarranted, as the name of *Hipponoë* has originally only been published as a nomen nudum, for which no species is given as the type. That Gray himself has later shown Agassiz, which species he regarded as the type of his genus *Hipponoë* (Agassiz, 7), does not justify the adoption of this name, any more than the assertion of Agassiz senior that if the name of *Hipponoë* proves to be a synonym of his *Tripneustes*, the former is to be preferred (Introd. to Valentin's Anat. du genre Echinus. p. IX.). As well known the author of a name has himself no more command of it

[1]) The name of *Toxopneustes* has first been proposed by L. Agassiz in «Observations sur les progrès récens de l'histoire naturelle des Echinodermes». (Monographies d'Echinodermes. p. 7.) «Dans un travail encore inédit sur les espèces vivantes de l'ancien genre *Echinus* .... j'ai établi les coupes suivantes, dont je me bornerai à citer ici les types: *Temnopleurus* (*E. toreumaticus*), ... *Toxopneustes* (*E. pileolus*)». Later, in the preface to Valentin's «Anatomie du genre Echinus», p. X. Agassiz says of *Toxopneustes*: «Je prends pour type de ce genre *l'Echinus tuberculatus*». — As a matter of course *pileolus* must have the prior right to the name of *Toxopneustes*.

than others, when it has first been published. I must decidedly follow Bell and de Loriol in the opinion that the name of *Tripneustes* has the priority.

The species »*Echinus*» *Robillardi*, *darnleyensis*, and *verruculatus* belong, as stated above, also here, but to which genus? They have, all of them, a primary tubercle on all the ambulacral plates; by this feature they are excluded from the genera *Toxopneustes* and *Tripneustes*, this character being here evidently of rather more value than among the *Echinus*-species. They must then either be referred to *Psammechinus* or form a new genus. In *verruculatus* the buccal membrane contains numerous fenestrated plates, to be sure much smaller and finer than in *variegatus*, where the buccal membrane is closely covered with large, thick plates; but in this respect *semituberculatus* keeps an intermediate position between the two, so that no definite limit can be given. The feature is quite analogous with that of *Parechinus microtuberculatus*, *miliaris*, and *angulosus*. Otherwise I can see no character that would justify a referring of this species to another genus. The mouth-slits are in no way smaller than in small specimens of *variegatus* of a corresponding size; in a specimen of *verruculatus* of a diameter of 21^{mm} they have a depth of 1^{mm}, in a specimen of *variegatus* of a diameter of 23^{mm} they have only the same depth. Further the coloration of the test in young *variegatus* is so very similar to that typical of *verruculatus*, that a comparison gives the immediate impression that they must be very closely allied. Accordingly I can only regard it as correct to refer this species to the genus *Psammechinus*, where it has already been referred by Lütken — who did not, to be sure, interpret the genus *Psammechinus* in the way it is done here, since he establishes the genus *Psilechinus* for *Ps. variegatus*, and in the same paragraph he names *verruculatus* as a typical *Psammechinus*[1]).

The species *Robillardi* and *darnleyensis* are distinguished from *Psammechinus* by their naked buccal membrane; it is, as described above, quite naked with the exception of the buccal plates, but contains more or fewer irregular spicules in the inner edge. The spicules of the pedicellariæ are not quite dumb-bell-shaped as in *verruculatus* and the other *Psammechinus*-species, but are formed as bows, which are a little thicker at the ends or of the same thickness in their whole length. These two features, I think, render the referring to the genus *Psammechinus* impossible, and they must consequently form a separate genus, for which I propose the name of **Gymnechinus**.

Whether *Toxopn. maculatus* really belongs to *Toxopneustes* or must rather be referred to another genus cannot be decided from the existing descriptions.

To the genus *Evechinus* Verr. are referred the species *chloroticus* (Val.), *australiæ* Woods, and *rarituberculatus* Bell; of these I have examined *chloroticus* and *rarituberculatus* (the type specimen), with regard to which I can give the following informations in addition to what is hitherto known.

Evechinus chloroticus (Val.). The 4—5 nethermost ambulacral plates have all a primary tubercle, then only every other plate, and above the ambitus only every third plate has a primary tubercle. In small specimens a primary tubercle will thus be found on every other plate on the abactinal side. The small spines are club-shaped. The buccal membrane inside and outside the buccal plates is richly provided with rather small, simple fenestrated plates, some of those outside the buccal plates are complicate and carry pedicellariæ. No spines on the buccal plates. The globiferous pedicellariæ (Pl. XIX. Figs. 6, 12) are very characteristic. There is only one unpaired, very strong lateral

[1]) Bidrag til Kundskab om Echiniderne. p. 27.

tooth; the outer corners of the basal part are strongly produced in a wing-shaped manner, and the holes in the corners are most frequently somewhat lengthened. No neck or perhaps a short one; as I have only had dried specimens for examination, I have not been able to decide this fact with certainty; the stalk compact. In the tridentate pedicellariæ (Pl. XIX. Fig. 39) the blade is rather broad with a strong, somewhat thorny net of meshes at the bottom. The edge is strongly indented, especially in the outer half, where the valves join; in the lower half they are apart, but not very much. The ophicephalous pedicellariæ have an almost straight edge, which is otherwise finely serrate as usual; the teeth, as is often the case, continue down the upper ends of the apophysis. The triphyllous pedicellariæ (Pl. XIX. Fig. 29) are very peculiar, the upper end of the apophysis forming a cover-plate, from which digitate projections pass over the blade, which is curved strongly inward in the middle. The edge smooth as usual. The spicules are bihamate, very few in number.

Evechinus raritubereulatus Bell is by Farquhar (145) taken to be young specimens of *E. chloroticus*. It is certain that it is very similar to *chloroticus*, but I cannot regard it as proved that it is synonymous with this species, as the tridentate pedicellariæ (Pl. XIX. Fig. 7) show a considerable difference from those of *chloroticus*. They have no coarse indentations in the edge, which is almost straight and very slightly serrate, only at the lowermost part there are a few larger indentations; the net of meshes in the bottom is slight, not thorny. The valves join through almost their whole length. — Perhaps similar pedicellariæ may be found in *chloroticus* together with the form described above; in my specimens, however, I have not been able to find such. For the present I must then regard *raritubereulatus* as a separate species. — The globiferous and ophicephalous pedicellariæ are quite as those of *chloroticus*, the triphyllous ones I have not seen. — Of *Evech. australiæ* Woods I know nothing.

Agassiz (Rev. of Ech. p. 502) thinks *Evechinus* to be closely allied to *Tripneustes* (*Hipponoë*); that there is no nearer relation at all between these two genera is seen with all desirable distinctness from the facts given above. The unpaired lateral tooth on the globiferous pedicellariæ draws the attention to *Pseudechinus albocinctus*; but the naked buccal membrane in the latter and the fact that a primary tubercle is here found on all the ambulacral plates, do not indicate a very near relation between the two forms. A quite similar form of globiferous pedicellariæ is found in »*Strongylocentrotus*» *tubereulatus* and closely allied species, and these, no doubt, are its nearest relations. A more thorough inquiring into this question must, however, be put off, until these species are treated.

In Cat. rais. the species *variolaris* Lamk., *paucituberculatus* Blainv., and *chloroticus* Val. are enumerated under the genus *Heliocidaris*. — For the first of these species the older name of *Stomopneustes* must be used; according to Agassiz (Rev. of Ech.) *paucituberculatus* is synonymous with this. As far as I can see, *chloroticus* must then be the type of the genus *Heliocidaris*; the name of *Evechinus* Verr. (1871) must then be dropped as being a much younger one, and I cannot but wonder, why Agassiz, who otherwise takes great care to reestablish the oldest names, has here preferred the name of *Evechinus*.

To the genus *Sphærechinus* Desor the species *granularis* (Lamk.), *roseus* Russo, *australiæ* A. Ag., and *pulcherrimus* (Barn.) are referred; of these I have had no occasion to examine *Sph. roseus*, but

the existing figures and the description (347) show distinctly that it is closely allied to *granularis*. The other three species I have examined, and can give some new informations of them.

Sphærechinus granularis (Lamk.). All the ambulacral plates have a primary tubercle. The buccal membrane contains outside of the buccal plates only few, small fenestrated plates, but they are thick and carry pedicellariæ, inside of the buccal plates there are numerous small, little complicate fenestrated plates. No spines on the buccal plates. The globiferous pedicellariæ, which have often been described and figured, have a tubular blade without lateral teeth (Pl. XXI. Figs. 35, 37); the end-tooth is peculiarly furrowed, so that it is a little difficult to see the open canal on the upper side. No neck. Glands on the stalk are found (were formerly only known in this species), the stalk tubular or compact[1]). The tridentate pedicellariæ (Pl. XXI. Fig. 34) with a well developed net of meshes, almost to the point of the blade; the edge is thick with an indication of transverse series of teeth. The valves are apart for about half their length, but the slit between them is rather narrow. The length of the head up to 2mm. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules in the globiferous pedicellariæ are slightly thickened at the ends (Pl. XXI. Fig. 12), but not really dumb-bell-shaped. In the tube feet only a few spicules are found just below the sucking disk; they are bihamate with small branches on the outside at both ends — quite as in *Toxopneustes pileolus*. In the buccal membrane, especially nearest to the gills, and in the gills, fine, genuine bihamate spicules are found; in the gills the usual irregular fenestrated plates are also found.

Sphærechinus australiæ Ag. agrees with regard to spicules and pedicellariæ exactly with *granularis*. Whether a primary tubercle is found on all the ambulacral plates, I cannot tell with certainty, as I have omitted the examination of this feature during my stay at British Museum; but as all other polypore Echinids that I know, have a primary tubercle on all the ambulacral plates, there can scarcely be any doubt that the fact is the same in this species. In Challenger-Echinoidea (p. 106) *Sph. australiæ* is mentioned from st. 162 (Bass's Strait). In British Museum I have examined the specimen upon which this statement rests, and have found that it is no *Sphærechinus* at all. The globiferous pedicellariæ have one unpaired lateral tooth, and recall those of *Strongylocentrotus tuberculatus* very much; otherwise I shall not decide to which genus and species this young specimen belongs, but rest satisfied with having pointed out that it is no *Sphærechinus*.

Sphærechinus pulcherrimus (Barn.), as well by its whole habitus as by its spicules and pedicellariæ, differs so much from the other *Sphærechinus*-species that there can be no question of referring it to this genus. On the other hand it shows great conformity with some *Strongylocentrotus*-species (*intermedius* and *chlorocentrotus*), and so it will be more particularly mentioned together with these species.

Agassiz says of the genus *Sphærechinus*: «this genus can hardly rank as more than a subgeneric division of *Strongylocentrotus*; the presence of deep, sharp cuts in the actinal system and the regularity of the arrangement of the tubercles, although giving to the species of this genus a striking facies, are simply quantitative characters, the value of which a better acquaintance with the subject will determine» (Rev. of Ech. p. 451). I shall readily admit that the difference between the deep slits

[1]) The so-called «Globiferæ» (Hamann 184) can only be interpreted as globiferous pedicellariæ, where the glands on the stalk have been highly developed at the cost of the head. The head is perhaps even torn off; at all events it is a sure fact that animals which are attacked by the pedicellariæ, can tear off the heads of the globiferous pedicellariæ. The so-called *Trichælina paradoxa* (Barrois. 28), as is a well known fact, is only torn-off heads of globiferous pedicellariæ.

in *Sphærechinus* and the small ones in *Strongylocentrotus* is a quantitative one, as also the difference between the numerous tubercles in the former and the fewer ones in the latter genus. This, however, does not preclude the fact that especially the deep slits are a character very sharply distinguishing *Sphærechinus* from *Strongylocentrotus*. But other characters are found, not quantitative, but structural, which also make a sharp distinction between the two genera, viz. spicules and pedicellariæ (comp. the description below of *Strongylocentrotus drobachiensis*). There can be no question at all of making *Sphærechinus* only a subgenus of *Strongylocentrotus*; it is a very well characterized genus, evidently most closely allied to *Psammechinus*, *Toxopneustes* etc.

To the genus *Pseudoboletia* Troschel are, in «Rev. of Ech.» referred the species *granulata* (Ag.) and *indiana* (Mich.); of the latter Prof. de Loriol has kindly sent me a specimen. To the description of this species by Agassiz and de Loriol (245) I can add the following informations. A primary tubercle is found on all the ambulacral plates. The buccal membrane contains, besides the numerous thick plates carrying both spines and pedicellariæ, a great number of dumb-bell-shaped spicules and some bihamate ones; inside of the buccal plates numerous small, rather thick fenestrated plates without spines or pedicellariæ, and a few spicules, most of which are bihamate, almost none of them dumb-bell-shaped. The gills with common fenestrated plates, a few dumb-bell-shaped spicules, and innumerable bihamate ones. The globiferous pedicellariæ as in *Sphærechinus*; they are strikingly different as to size, but otherwise similarly constructed. The figure given by Agassiz in «Challenger»-Echinoidea (Pl. XLIV. Fig. 38) is not quite good, as the end-tooth seems there to be constructed quite as the tubular blade; I need scarcely mention that it is constructed in the common way. In the same place is given a rather good figure of a tridentate pedicellaria (Fig. 39), the only objection is that the oblique striæ in the blade give a somewhat coarse idea of the little developed net of meshes in the blade. The edge is thick with numerous small teeth, which in the lower part are placed in transverse series, in the outer part irregularly. Ophicephalous and triphyllous pedicellariæ of the common form. The stalk compact. In the globiferous pedicellariæ numerous spicules are found of about the same form as in *Sphærechinus*; the same form is also found in the tube feet, especially near the sucking disk, together with bihamate spicules that are not branched in the ends.

According to Agassiz (Rev. of Ech. p. 153) *Pseudoboletia maculata* Troschel is synonymous with *Ps. indiana*. De Loriol (op. cit.) does not think them to be the same species, and Bell (53) follows this opinion, and maintains farther that *Ps. granulata* is identical with *indiana*. After having examined a couple of specimens of *Ps. maculata* in British Museum I must also regard *maculata* as a well distinguished species. The globiferous pedicellariæ are as in *indiana*, the glands of the stalk are peculiarly lengthened and narrow, almost linear. (Whether this also holds good with regard to *indiana*, I am not able to decide by the dried specimen in hand.) The tridentate pedicellariæ (Pl. XXI. Fig. 1) yield scarcely a sure mark of distinction from *indiana*; together with the large form (the head up to $1{\cdot}5^{mm}$) where the valves join only in the outer half, a smaller, somewhat different form is found (Pl. XXI. Fig. 17) where the valves join through their whole length. The ophicephalous pedicellariæ (Pl. XXI. Fig. 5) are peculiarly elongate with almost straight, finely serrate edge and little developed mesh-work. It is, however, to be observed that on the buccal membrane of *Ps. indiana* ophicephalous pedicellariæ are found, resembling the figured one rather much, and as I do not remember, and have

made no note, whether those of *Ps. maculata* are taken exclusively from the buccal membrane or perhaps also from the test, I do not venture for the present to put too much stress on this feature. The triphyllous pedicellariæ and the spicules show no difference from *Ps. indiana*. — The features stated here, together with those mentioned by de Loriol and Bell: the size of the peristome and the slits etc., and especially the peculiar coloration, which, according to de Loriol, is not found in *indiana*, seem to leave no doubt of the fact that they are two well distinguished species.

In Rev. of Echini» *Pseudoboletia* like *Sphærechinus* is enumerated as a subgenus of *Strongylocentrotus*, and at the end of the diagnosis (p. 455) it is thereupon said: This is an interesting genus, forming, as it were, a link between the Echinometradæ and Echinidæ; its position is still doubtful». In none of these statements I can agree with Agassiz. *Pseudoboletia* is neither a subgenus of *Strongylocentrotus* nor a transitional form between Echinometrids and Echinids, and its position is not at all doubtful — it is a near relation of *Sphærechinus*. It agrees with *Sphærechinus* with regard to the pedicellariæ, the spicules of these, the number of pores, and the structure of the test; only in two features a difference of any importance is found: the spicules of the tube feet are simply bihamate (in *Sphærechinus* a little branched in the ends) and — as the more important fact — the buccal plates and the other plates of the buccal membrane are set with small spines and pedicellariæ (in *Sphærechinus* only with pedicellariæ). That the spines are a little longer and the test somewhat more flattened than in *Sphærechinus* can hardly be used as a generic character. Thus it is rather unimportant characters, by which *Pseudoboletia* is distinguished from *Sphærechinus*; at all events, however, the peculiar covering with spines of the buccal membrane seems to be a sufficient reason for the keeping of the genus, and nothing would be gained by uniting it with *Sphærechinus*.

The genus *Strongylocentrotus* Brandt is in Rev. of Echini (p. 276) enlarged to comprise «all species having a somewhat circular or subpentagonal, regularly arched or slightly depressed test, with smooth, imperforate, not crenulate tubercles of unequal sizes, forming primary and secondary vertical rows. Pores arranged in arcs of at least four to five pairs. Actinostome decagonal; very slight cuts; buccal membrane bare; spines moderately slender, longitudinally striated, longer proportionally than those of true *Echinus*, and more slender than those of *Sphærechinus*». According to this diagnosis a great number of species will be referred to this genus, viz. *albus* (Mol.), *armiger* Ag., *depressus* (Ag.), *drobachiensis* (Müll.), *erythrogrammus* (Val.), *franciscanus* (Ag.), *Gaimardi* (Blainv.), *gibbosus* (Val.), *intermedius* (Barn.), *lividus* (Lamk.), *mexicanus* (Ag.), *nudus* (Ag.), *purpuratus* (Stimpson), *tuberculatus* (Lamk.); to which are to be added some species which Agassiz, but no doubt wrongly, regards a synonyms, viz. *chlorocentrotus* (Brandt), *globulosus* Ag. (according to Rathbun, 337. p. 274), and *omalostoma* (Val.); finally a new species, *bullatus*, has been described by Bell (46). Further *Sphærechinus* and *Pseudoboletia* are classed as subgenera of *Strongylocentrotus*. The homogenous nature of the genus as now limited cannot fail to be apparent», says Agassiz (loc. cit.). A closer examination shows, however, that this large genus is anything but homogenous. Apart from *Sphærechinus* and *Pseudoboletia* there proves to be among the mentioned species at least 6 well characterized genera, which are to be referred to 3 different families! Perhaps still other genera may be represented among the species I have had no occasion to examine. I must grant Agassiz to be right, when he says that it is impossible «upon the mere question of quantity or direction of the pores to subdivide this genus»; but for-

tunately other characters are found which prove to be quite efficient, above all the pedicellariæ and the spicules. The species *mexicanus*, *nudus*, and *globulosus* I have not seen. The other species may be divided into 5 groups, which I shall here characterize.

Strongylocentrotus drobachiensis (Müll.). Primary tubercle on all the ambulacral plates; the buccal membrane with rather few plates outside of the buccal plates, some of them thick carrying pedicellariæ; inside of the buccal plates there are more smaller, smooth or somewhat complicate plates. The globiferous pedicellariæ are highly characteristic, having a long neck provided with as well circular as longitudinal muscles, so that it may be retracted and stretched out (Pl. XX. Figs. 25, 29). The valves have a tubular blade without lateral teeth; the stalk is tubular, its upper end with peculiar ribs. The tridentate pedicellariæ are very much varying as to form (Pl. XX. Figs. 4, 6, 20); the small teeth on the edge may form beautiful transverse series; the ophicephalous and triphyllous pedicellariæ show no conspicuous peculiarities. The spicules of the pedicellariæ and tube feet are branched in the ends (Pl. XX. Fig. 12), otherwise most nearly of the bihamate form; simple bihamate spicules may also be found. In the globiferous pedicellariæ a dense series of spicules is often found along the outer edge of the valves (Pl. XX. Figs. 25, 29).

The same peculiar form of globiferous pedicellariæ is found in the species *purpuratus* (Stimps.), *intermedius* (Barn.), *franciscanus* (Ag.) (probably), and *chlorocentrotus* Brandt. In *St. purpuratus* the globiferous pedicellariæ are distingnished by the uncommonly well developed articular surface (Pl. XX. Figs. 14, 28); the stalk is strong, and seems to be compact. The tridentate pedicellariæ resemble very much the smaller form with the large indentations in *drobachiensis* (Pl. XX. Fig. 20), only the net of meshes is a little more developed. — Of *Str. franciscanus* I have only seen a large, fine, dried specimen in British Museum, and unfortunately I could find no globiferous pedicellariæ on it; but as the spicules of the tube feet are quite identical with those of *drobachiensis*, I have no doubt that also its globiferous pedicellariæ agree with those of this species. The tridentate pedicellariæ of very different form; in this one specimen no less than three different forms were found corresponding to the three forms figured from *Str. drobachiensis*. The larger ones have a strong net of meshes, the smaller ones almost none. — Of *Str. intermedius* a fine specimen is found in the museum of Copenhagen (received from the museum in Vienna), and further I have examined a specimen in British Museum. The two specimens prove, however, to be two different species, and it is not easily decided, which is the real *intermedius*. As far as I can see from the description in Rev. of Ech. and in Sladen (365. p. 434) the specimen in the museum of Copenhagen must really be *intermedius*. There are only four pairs of pores in each arc, and the spicules seem all to be simple, bihamate. The tridentate pedicellariæ resemble those of *Sphærechinus pulcherrimus* (Pl. XX. Fig. 10). The specimen in British Museum has also globiferous pedicellariæ with neck and branched spicules.

Str. chlorocentrotus Brandt is by Agassiz regarded as synonymous with *drobachiensis*, but no doubt wrongly. In the description of Brandt[1]) it is said among other things: „spinæ breves, virides, maximæ 4 linearum longitudinem vix superantes, latitudinem autem lineæ dimidiæ partis æquantes". (The diameter of the test is given to be 1—1½"). This does not hold good with regard to *drobachiensis*. De Loriol (248) has lately described a species from Sitka, which he refers to *Str. chlorocen-*

[1]) Prodromus etc. p. 64.

trotus. In our museum is found a small Echinid from Japan, received from the museum in Vienna under the name of *Str. intermedius*; this determination is scarcely correct, but it might agree with the description of *chlorocentrotus*. At all events it is another species than that of de Loriol; it has four pairs of pores, while Brandt gives 5 pairs. (That of de Loriol has 7—5 pairs). In this specimen the globiferous pedicellariæ are as in *drobachiensis*; but the spicules are simple, bihamate. Nothing definite can be said of *Str. chlorocentrotus*, until the type specimen has been reexamined.

To the species here mentioned, especially *intermedius* and *chlorocentrotus* (?) has to be added *Sphærechinus pulcherrimus*, of which I have received a couple of specimens from Prof. Döderlein; some specimens of this species were further found among some Echinids from Japan, which Prof. d'Arcy Thompson has sent me for examination. Of this species I shall give the following informations. A primary tubercle is found on all the ambulacral plates (as in all the preceding species and, as far as I know, in all polypore species). Only four pairs of pores in each arc, as in *intermedius* and *chlorocentrotus* (mentioned by Agassiz). Three ocular plates reach to the periproct. The buccal membrane is highly pigmented, with numerous small fenestrated plates, some few of those outside the buccal plates thick, with pedicellariæ. The globiferous pedicellariæ quite as in *drobachiensis*; of tridentate pedicellariæ a larger form is found (Pl. XX. Fig. 10), a little widened at the point and with rather sinuate edge, and a smaller form, where the edge is straight or only very slightly sinuate. The other pedicellariæ show no peculiarities. The spicules are bihamate, not branched.

As none of the other species referred to *Strongylocentrotus* — and, upon the whole, no other Echinids of *Triplechinidæ* and *Echinometradæ* that I know, with the exception of the *Anthocidaris homalostoma* Ltk. mentioned below — have the same peculiar form of globiferous pedicellariæ, it is evident that the mentioned species form a separate group, while it is a less sure fact whether they form also one genus. The species *pulcherrimus*, *intermedius*, and *chlorocentrotus* (?) are distinguished from the others by having simple bihamate spicules, only four pairs of pores in each arc, and by the very flat form of the test; in all of them the spines are very short, the primary ones very little conspicuous, also the primary tubercles are only little conspicuous among the numerous secondary tubercles arranged in horizontal series. I am most inclined to interpret these species as a particular genus (they form, perhaps, even only one species), which genus, if the mentioned specimen should really prove to be identical with Brandt's *Str. chlorocentrotus*, must get the name of *Strongylocentrotus*. The other species: *drobachiensis*, *purpuratus*, and *franciscanus*, would then have to form a separate genus, which, if the name of *Strongylocentrotus* is to be restricted to the above named species, must get the name of *Eurycchinus* Verrill[1]). As long as we have no sufficient knowledge of the species that has to be called *Strongylocentrotus*, viz. *chlorocentrotus* Br., it will be most correct to call all the species mentioned here *Strongylocentrotus*, and leave the name of *Eurycchinus* for disposal, if it should prove to be necessary to use it.

Strongylocentrotus depressus (Ag.). Of this species I have received a specimen from Prof. Döderlein, and another specimen I have found among the Echinids from Japan sent me for determination by Prof. d'Arcy Thompson. Accordingly I am able to give some informations of it, which

[1]) E. A. Verrill: On the Polyps and Corals of Panama, with descriptions of new species. Proc. Boston Soc. Nat. Hist. X. 1866. p. 340.

may be found to be so much the more important, as the description of this species by Agassiz is very unsatisfactory, and we have no figures of it at all. A primary tubercle is found on all the ambulacral plates; the pore areas of the actinal side are much extended, a little petaloid; the two lowermost plates have only three pairs of pores. Two ocular plates reach to the periproct. The buccal membrane contains numerous lengthened fine fenestrated plates, only a few are complicate and carry pedicellariæ; a few small bihamate spicules in the buccal membrane. No spines on the buccal plates. The gills contain the usual irregular fenestrated plates, but no bihamate spicules. The slits of the test not large, but very distinct. The globiferous pedicellariæ are as in *Sphærechinus*, but here no glands are found on the stalk. The tridentate pedicellariæ occur in three different forms (Pl. XXI. Figs. 8, 9, 15); between the two former of these transitions may perhaps be found, while no transitional forms seem to be found between the latter two. The teeth on the edge form no transverse series. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules in the globiferous pedicellariæ (Pl. XXI. Fig. 14. b) are chiefly as in *Sphærechinus*, only more lengthened; those of the tube feet are rather much branched, but they belong, however, to the bihamate form (Pl. XXI. Fig. 14. a); they are numerous in the abactinal tube feet, but very few in number in the actinal ones.

It is evident from the features mentioned here that this species is not closely allied to the *Strongylocentrotus*-species mentioned above. Its nearest relation, no doubt, is *Sphærechinus*; but it cannot be referred to this genus either; especially the strong extension of the pore areas on the actinal side renders the referring to *Sphærechinus* impossible, as in the latter no indication of such an extension is found. The form is also very different from the high form of *Sphærechinus*. The slits of the test, on the other hand, are scarcely to be used as a distinguishing mark, as they are not much smaller than in specimens of *Sphærech. granularis* of a corresponding size. A new genus must be formed for this species, and for this genus I propose the name of **Pseudocentrotus**.

Strongylocentrotus albus (Mol.). A primary tubercle is found on all the ambulacral plates; on the lowermost ones there are only three pairs of pores. One ocular plate reaches to the periproct, the others almost reach it. The buccal membrane with numerous, rather large, lengthened fenestrated plates, some of those outside the buccal plates thick, carrying pedicellariæ. No spines on the buccal plates. The globiferous pedicellariæ are very similar to those of *Parechinus miliaris* etc., but the apophysis ends far from the edge of the blade (Pl. XVII. Fig. 5); there is a short, but distinct neck, only, however, containing longitudinal muscles, not also circular muscles, so that it cannot be retracted and stretched out as in *Str. drobachiensis* etc. The tridentate pedicellariæ are very peculiar (Pl. XVII. Fig. 18), with a keel in the middle of the blade, which is short and narrow; the point is a little widened with 3—4 strong teeth on either side. There are no transverse series of small teeth. The ophicephalous pedicellariæ are somewhat lengthened, but without conspicuous peculiarities; the triphyllous pedicellariæ of common form. The stalk of the globiferous and triphyllous pedicellariæ consists of long, slender calcareous threads, almost only connected at the ends of the stalk; the stalk of the tridentate and ophicephalous pedicellariæ is compact. The spicules bihamate, very few in number.

With *Str. albus* must be classed the species *gibbosus* (Val.) and *bullatus* Bell. With regard to

pedicellariæ they are so very similar to *albus*, that herein scarcely any specific difference can be pointed out. In *gibbosus*, however, I have only seen a small form of tridentate pedicellariæ (Pl. XVII. Fig. 12); but I suppose that also the peculiar large form is found in this species, and likewise may perhaps the small form be found in the two other species, although I have not found it. It is, however, to be noted that *gibbosus* has only 4 pairs of pores, while the two others have 7—8 pairs; and so it would be no strange thing, if its tridentate pedicellariæ were different from those of the others. As in *albus* only very few bihamate spicules are found. Agassiz (Rev. of Ech. p. 444) states that three ocular plates reach to the periproct; on the specimen I have examined (Challenger st. 304, western coast of Patagonia), no ocular plate reaches to the periproct. The same fact holds good with regard to *bullatus*. (Of *Str. bullatus* I have examined the type specimens in British Museum, of *albus* a couple of specimens are found in the museum of Copenhagen.)

That these species are nearly related is quite undoubtful, and it is as sure a fact that they have nothing to do with the real *Strongylocentrotus*-species. They must form a separate genus getting the name of *Loxechinus* Desor[1]), which has just been established for *Echinus albus* Mol. As already mentioned the globiferous pedicellariæ are constructed as in *Parechinus* (*miliaris* etc.), apart from the short neck, and I must regard these two genera as closely allied, so that *Loxechinus* is chiefly to be regarded as a polypore *Parechinus*. That the whole habitus of the *Loxechinus*-species recalls *Parechinus* very much, speaks, of course, together with the other features, also in behalf of such a relation, although a similar habitus alone in no way can be regarded as a proof of near relationship (comp. *Pseudocentrotus depressus* and *Anthocidaris homalostoma*).

Strongylocentrotus lividus (Lamk.). Of this species, which is so well known especially by the examinations of Valentin, I can give no new informations; I shall only here mention the features which in my opinion are of essential importance for the determination of its systematic position, but which are generally omitted in the systematic descriptions. A primary tubercle is found on all the ambulacral plates; in the lower ambulacral plates there are only three pairs of pores. In the smaller specimens all the ocular plates are shut off from the periproct, in the larger ones one or two may reach to it. The buccal membrane contains rather few fenestrated plates; most of those outside of the buccal plates are thick, round, and carry pedicellariæ; nearest to the edge a sphæridia may be found, sometimes one more may be found farther in on the buccal membrane. There are no spines on the buccal plates or on the other plates of the buccal membrane. To be sure Valentin says (Anatomie du genre Echinus. p. 62): »il existe encore à la surface de la membrane buccale de petits piquants microscopiques, dont la structure ne diffère en rien de celle des piquants«; but I suppose it to be stalks of pedicellariæ he has mistaken for spines. On the figure to which he refers, no spines are found, but only stalks of pedicellariæ. The globiferous pedicellariæ are most nearly alike to those of *Parechinus*. The blade is quite open with 1—1 lateral tooth (Pl. XVII. Fig. 19), but the edge is thick, not thin and sharp as in *Parechinus*. There is no neck; the stalk consists of long, thin threads, only little connected, except at the ends of the stalk. (Also in the other pedicellariæ the stalk is constructed in this manner.) The tridentate pedicellariæ are very peculiar with long, narrow blade, coarsely serrate through the whole edge (Pl. XVII. Fig. 21); there are no small teeth. The ophice-

[1]) Synopsis des Ech. fossiles. p. 136.

phalous pedicellariæ have only a strong keel in the middle of the blade, as is seen on the figures of Valentin; otherwise almost no net of meshes is found. The triphyllous pedicellariæ of the common form. The spicules bihamate; I have only found them in the buccal tube feet. — Otherwise I may refer to Valentin's excellent figures of pedicellariæ and spicules.

Very closely allied to *Str. lividus* is *Str. Gaimardi* (Blainv.); it agrees exactly with *lividus* with regard to pedicellariæ and spicules. Unfortunately I have not been able to find tridentate pedicellariæ on any of the three specimens found in the museum of Copenhagen, and it is just in the tridentate pedicellariæ we might expect to find the difference. I shall express no definite opinion as to the fact, whether it be really the same species as *lividus*, what Agassiz is inclined to think; at all events the tridentate pedicellariæ must be examined, before the question can be answered with certainty. The peculiar, striped apical plates seem, however, to indicate that it is a distinct species.

It is a sure fact that these two species have nothing to do either with the genuine *Strongylocentrotus*-species or with *Pseudocentrotus*; on the other hand they seem to be more nearly allied to the genus *Loxechinus*, a rather great resemblance being found between the globiferous pedicellariæ. These pedicellariæ, however, seem to remind more of the genus *Echinus* itself, where globiferous pedicellariæ with quite open blade may also sometimes be found (*Ech. Alexandri*). Also the tridentate pedicellariæ remind most of the long, narrow form common in *Echinus*. As *Loxechinus* seems to be a polypore *Parechinus*, so must also, I suppose, *Str. lividus* be regarded as a polypore form of *Echinus*. That it must form a separate genus is not to be doubted. I propose the name of **Paracentrotus.**

Strongylocentrotus tuberculatus (Lamk.). To the description of this species by Agassiz (Rev. of Ech. p. 449) the following informations must be added. A primary tubercle is found on all the ambulacral plates; two ocular plates reach to the periproct. The buccal membrane contains comparatively few plates, all those outside of the buccal plates, with the exception of the plates at the very edge, are thick and carry pedicellariæ. Inside the buccal plates a rather great number of small fenestrated plates are found. The globiferous pedicellariæ have glands on the stalk; no neck; the valves (Pl. XIX. Figs. 4, 13), are constructed as in *Echinometra*: with one unpaired lateral tooth, almost as large as the end-tooth, but, of course, without a poison-canal on the upper side. The blade is tubular, but not quite closed; the basal part is much widened with the fore corners a little produced in a wing-like manner. The tridentate pedicellariæ occur in two forms, a more narrow one (Pl. XIX. Fig. 8) with only little developed net of meshes, and a broader one (Pl. XIX. Fig. 9) with a well developed net of meshes, the meshes of which are somewhat lengthened, especially towards the point of the blade. On the lower part of the edge transverse series of small teeth are found. The ophicephalous and triphyllous pedicellariæ show no peculiarities. The stalk of the pedicellariæ compact. The spicules bihamate, also those of the globiferous pedicellariæ.

Strongylocentrotus erythrogrammus[1]) and *armiger* correspond so exactly with *tuberculatus* with regard to pedicellariæ and spicules, that a reliable specific difference is scarcely to be found in these features; I have not, however, seen the broad form of tridentate pedicellariæ in these two species.

That we have here a type which cannot be classed with any of the preceding genera, is

[1]) Not *eurythrogrammus*, as it is wrongly spelled in Rev. of Echini.

evident; these three species must form a separate genus which gets the name of *Toxocidaris* Ag.[1]). As the first species of this genus (of which no diagnosis is given) is named *T. Delalandi* Ag., which is synonymous with *erythrogrammus* (Rev. of Ech. p. 163); thus this species becomes the type of the genus *Toxocidaris*. Agassiz is surely right when he maintains (Rev. of Ech. p. 450) that the somewhat petaloid structure of the pore areas on the actinal side is no valid generic character of *Toxocidaris*, but the peculiar globiferous pedicellariæ leave no doubt of the correctness of the genus with the limitation given here.

As a synonym of *Strongyloc. tuberculatus* Agassiz (Rev. of Ech. p. 165) names *Anthocidaris homalostoma* Lütken[2]). I am so fortunate as to be able to prove this to be incorrect. The specimens of Lütken are only naked tests, of which one is from China, for the others no locality is given. Among the Echinids from Japan, sent me by Prof. d'Arcy Thompson, is a specimen, which with regard to the structure of the test agrees so exactly with the specimens of Lütken, that there can be no doubt of their being identical. So I shall here give the necessary informations of this species. The specimen in hand has a diameter of 30[mm], and is from Yokohama Bay. The primary tubercles of the ambulacral areas are almost as large as the interambulacral primary tubercles. There is an irregular series of small tubercles in the middle, and a similar one outside of the primary series on either side; this outer series is formed of a larger and a smaller tubercle alternately, a larger tubercle being found below on each ambulacral plate, and a smaller one above; besides some small tubercles are found outside the latter ones, nearer to the pores. The interambulacral areas have a double series of secondary tubercles between the primary series, and one outside on either side; just at the ambitus two series are found outside of the primary ones, and all these tubercles form here distinct oblique series. The colour of the test is grayish green. The spines are thick, evenly tapering, the longest half as long as the diameter of the test; they are of a deep violet colour. Two ocular plates reach to the periproct. The pore areas are rather highly petaloid on the actinal side, and as only a few small spines are found nearest to the mouth, almost only tube feet are seen here. In the lower ambulacral plates only 3 pairs of pores are found, above there are 8—9 pairs. The buccal membrane contains rather numerous fenestrated plates, of which some of those outside of the buccal plates are thick and carry pedicellariæ. The gills contain the common irregular fenestrated plates. The slits distinct. The globiferous pedicellariæ are as in *Strongyloc. drobachiensis* with well developed neck (in the specimen in hand I succeeded only with much difficulty in finding one small globiferous pedicellaria). The tridentate pedicellariæ (Pl. XXI. Fig. 6) resemble much the narrow form in *Toxocidaris tuberculatus*; but also another form is found with the blade somewhat widened in the point, and with a more developed net of meshes. As I have not been able to find a whole specimen of this form, I have given no figure of it, so much the less as its seems that no great stress can be laid on the tridentate pedicellariæ as specific characters in most of the *Strongylocentrotus*-like forms. No transverse series of small teeth are found on the edge. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules of the tube feet are very characteristic (Pl. XXI. Fig. 30), biacerate, a little curved, generally with a rather strong point in the middle of the outer side.

[1]) List of Echinoderms etc. Bull. Mus. Comp. Zool. I. p. 22.
[2]) Bidrag til Kundskab om Echiniderne. p. 96.

That this form is widely different from *Toxocidaris tuberculatus* is evident from the characters mentioned here; on the other hand the globiferous pedicellariæ show that it is rather closely allied to *Strongylocentrotus*. But the peculiar spicules and the petaloid pore areas characterizes it sufficiently as a separate genus, which keeps, of course, the name of *Anthocidaris*. Lütken (loc. cit.) regards it as identical with *Echinus homalostoma* Valenc.; I do not know whether this is correct, but it is so far of no consequence, as this species will, at all events, get the name of *Anthocidaris homalostoma*. I suppose that this species has hitherto been confounded with *Toxocidaris tuberculatus*, which it resembles to some degree, and which is also said to occur at Japan. *T. tuberculatus*, however, is indigenous in the Australian seas, and until renewed examinations have corroborated its occurrence at Japan, I must suppose a confounding with *A. homalostoma* to have taken place. As to habitus *A. homalostoma* is very similar to *Pseudocentrotus depressus*, which latter has also petaloid ambulacra; but its colour is (always?) brownish red, and it is somewhat more flattened. The examination of pedicellariæ and spicules will immediately show them to be two widely different forms.

Where the species *Str. mexicanus*, *nudus*, and *globulosus* are to be referred, cannot be seen from the existing descriptions. The other species referred to *Strongylocentrotus* thus prove to belong to no fewer than 6 different genera: *Strongylocentrotus*, *Pseudocentrotus*, *Loxechinus*, *Paracentrotus*, *Toxocidaris*, and *Anthocidaris*, and it may perhaps even be necessary to divide the first one into two genera. And these genera are excellently characterized, and so far from being closely allied, that they are to be grouped into three different families. We can scarcely wish for a more striking proof of the insufficiency of the characters that are taken only from the test and the spines.

Stomopneustes variolaris (Lamk.). Of this very peculiar form I am able to give some new informations; I have not, however, had material sufficient for clearing up everything that might be wished for. — A primary tubercle is only found on every fourth or fifth ambulacral plate; each of these large tubercles spreads over more plates — but it is difficult to decide over how many, as no boundary lines are seen between the plates; it may, however, be seen from the pores that the fact is so, as more arcs are found opposite to each tubercle. Two ocular plates reach to the periproct. The buccal membrane contains numerous lengthened, fine fenestrated plates, of which a few are a little complicate and carry pedicellariæ. Small spines are found on the buccal plates. The gills contain numerous, mostly three-radiate spicules (Pl. XVII. Fig. 13), but not the common irregular fenestrated plates. The globiferous pedicellariæ are of a quite unique form. There is no end-tooth, but the blade ends truncately with a long tooth in each corner (Pl. XVII. Fig. 17), sometimes two teeth on one side, or that on the one side a little below the corner. These teeth have no poison canal, and upon the whole no poison gland seems to be found (I have not, however, been able to ascertain this fact with full certainty). The blade is open, rather flat, the apophysis ends abruptly without any widening above. There is no neck, and the stalk is very short and compact. This very peculiar, large, and powerful form of pedicellariæ is, unfortunately, very scarce; in the two specimens I have examined, I have only been able to find one in each specimen, placed in one of the interambulacral furrows near the ambitus. Besides another, smaller form of globiferous pedicellariæ seems to be found, with end-tooth and 1—1 lateral tooth, very similar to those of *Paracentrotus lividus*; but I have not been able to make quite sure of this fact. The tridentate pedicellariæ are distinguished by the apophysis

continuing some way into the blade as a distinct, a little serrate crest (Pl. XVII. Figs. 16, 20); the form is otherwise somewhat varying, as the blade may be more or less widened in the outer part; the larger ones have a rather powerful net of meshes, the small have almost none. The edge is rather coarsely serrate in the lower part, finely serrate towards the point; there are no transverse series of small teeth. A form as that figured by Agassiz (Rev. of Ech. Pl. XXIV. 31), where, moreover, the apophysis does not continue into the blade, I have not seen. Stewart (381) figures a valve of a tridentate pedicellaria, and mentions this crest. In the same place he figures a valve of an ophicephalous pedicellaria to which I may refer; they are dentate in the edge to an uncommonly high degree, although some difference is found in this respect, but I have not seen them with so smooth edges as in the figure by Agassiz (loc. cit. Fig. 32). The ophicephalous pedicellariæ have almost no neck, as has already been observed by Stewart. The stalk, which is, like those of the other pedicellariæ, thick and compact, has a little constriction above. The triphyllous pedicellariæ are uncommonly lengthened (Pl. XVII. Fig. 4) without teeth in the edge. What Stewart has taken to be triphyllous pedicellariæ (he does not figure them), I think to have been quite small, tridentate pedicellariæ. The great variation in the size of these (the tridentate) pedicellariæ, and the broad, spoon-shaped character of their jaws make the smaller forms closely resemble the trifoliate variety and lend weight to Prof. Agassiz's view, that the latter are rarely (sic! — early) stages of the former (381. p. 911). That there can be no question of this need not be more nearly explained here, a reference to the informations given above with regard to the development of the pedicellariæ, will be sufficient. The spicules of the tube feet are very peculiar; along one side of the tube foot is found a series of large spicules formed as long, fenestrated, thorny tubes; they are parallel to the longitudinal axis of the foot, and are placed in such a way, that the upper end is projecting, while the lower end is covered by the spicule following below. Towards the sucking disk the spicules become smaller, at last only flat, lengthened fenestrated plates. On the opposite side of the tube foot is often — but not always — found an irregular series of much smaller spicules more or less perforated. Stewart[1]) has given figures of these spicules, to which the reader is referred; I have never, however, seen the large spicules branched, as they are figured here, Stewart does not know in which species it is that he has found these remarkable spicules; later (381) it has become clear to him that it is *Stomopneustes variolaris*. — Whether *Stomopn. atropurpurea* Woods (447) is a separate species, or, as Ramsay (311. p. 11) thinks, only a variety of *variolaris*, I cannot tell with any certainty, as I have not seen this form, and the description gives no information of pedicellariæ and spicules. These structures must be examined, before the question can be definitively decided.

Parasalenia gratiosa Ag. I can only give little information of this very characteristic form beyond what has been stated by Agassiz, Lütken, and Stewart. A primary tubercle is found on all the ambulacral plates; the buccal membrane contains numerous, rather large, fine fenestrated plates, of which only a few are complicate and carry pedicellariæ. No spines on the buccal plates. The globiferous pedicellariæ have a tubular blade, without lateral teeth. No neck; glands seem to be found on the stalk, which is compact. The tridentate pedicellariæ are long and very narrow, finely serrate in the edge; they remind very much of those in *Paracentrotus lividus*, but the serrations are finer.

[1]) On the Spicula of the regular Echinoidea. Transact. Linn. Soc. XXV. Pl. L. fig. 1. 1865.

No transverse series of small teeth. The ophicephalous and triphyllous pedicellariæ without conspicuous peculiarities. The spicules of the globiferous pedicellariæ are bihamate, those of the tube feet of a very peculiar form: biacerate, a little arcuate, with two small, axe-shaped projections on the concave side (Pl. XXI. Fig. 32). — *Parasalenia Pöhlii* Pfeffer (314) I have not seen.

In »Revision of Echini» p. 423 the family *Echinometradæ* is defined as »having always more than three pairs of pores to each arc»; nevertheless *Parasalenia* is also referred to this family, although it has only three pairs of pores in each arc. Setting aside this contradiction is must be admitted that when only the form and habitus of the test is taken into consideration by the determination of the relationship of the Echinids, *Parasalenia* must be regarded as an oligopore Echinometrid. The examination of its pedicellariæ and spicules show, however, that it has no nearer relation with the Echinometrids. The spicules remind most of those in *Anthocidaris*, but are, nevertheless, very different also from these; also the globiferous pedicellariæ recall those of *Anthocidaris*, but are distinguished from these by having no neck. Thus it is not too closely allied to *Anthocidaris*, but it does not seem possible, at all events at present, to point out any nearer relation. That the structure of the spines is very different from that of the *Echinometra*-spines (Mackintosh 265, Stewart 381) is a further proof that *Parasalenia* has nothing to do with *Echinometra*; now, to be sure, we cannot lay any great stress on some difference in the structure of the spines, when this character is standing alone; but when, as in *Parasalenia*, it is added to other characters of more significance, it will also get some importance.

After it has been pointed out that *Parasalenia* is no Echinometrid, this form becomes of considerable interest as proving a parallel development within two different families.

Echinostrephus molare (Blv.). Also this peculiar form is well known, especially Stewart (381) has figured its pedicellariæ with the exception of the triphyllous ones; accordingly only the most important features are to be briefly mentioned here. A primary tubercle is found on all the ambulacral plates; all the ocular plates are shut off from the periproct. The buccal membrane with rather numerous fenestrated plates, not only opposite to the ambulacra (Rev. of Ech. p. 457); most of them are thick and carry pedicellariæ. No spines on the buccal plates; the gills with the usual irregular fenestrated plates. The globiferous pedicellariæ as in *Echinometra* with one large, unpaired lateral tooth. There is no neck; whether glands are found on the stalk could not be decided with certainty, as the examined specimen is a dried one. In the tridentate pedicellariæ the blade is widened in a somewhat spoon-shaped manner, rather strongly serrate in the edge in the outer part, without transverse series of small teeth; only a little developed net of meshes. The ophicephalous and triphyllous pedicellariæ of the common form. The stalk of the pedicellariæ compact. The spicules of tube feet and pedicellariæ bihamate. — Although this genus has most frequently trigeminate pores, it is also referred to *Echinometradæ* in »Rev. of Ech.»; this is no doubt correct, both spicules and pedicellariæ being as in *Echinometra*. — *Ech. pentagonus* Yoshiw. (449) not examined.

To the genus *Echinometra* are referred the species: *lucunter* (L.)[1]), *oblonga* (Blv.), *Mathæi* (Blv.),

[1]) Lovén (252. p. 153) has definitively shown the common Westindian *Echinometra* to be the *Echinus lucunter* of Linné; thus that species must keep the name, and the name of *E. subangularis* (Leske) used by Agassiz (Rev. of Ech.) must be rejected. The species from the Pacific for which Agassiz unjustly reserves the name of *lucunter*, must give up this name, and in future be called *Echinometra Mathæi* (Blv.), which name thus, according to Agassiz (Rev. p. 115), becomes the older one.

van Brunti Ag., *viridis* Ag., and *macrostoma* (Ltk.). Whether the last-named one is a genuine *Echinometra* cannot be decided for the present, as only naked tests and loose spines are known. The other species agree in the main features, also with regard to pedicellariæ and spicules; so there is no reason to enter into details with regard to the separate species, only a few features characteristic of the genus are to be mentioned. A primary tubercle is found on all the ambulacral plates; no ocular plate reaches to the periproct in *Ech. oblonga* and *viridis*, while in *lucunter* generally one plate, rarely two or none at all reach to it. The buccal membrane contains numerous large, but fine fenestrated plates, almost all without pedicellariæ. Spines on the buccal plates. The globiferous pedicellariæ have one unpaired, strong lateral tooth, as Perrier has pointed out, and he has figured it in an excellent manner[1]). There is no neck; the stalk is compact. In *E. oblonga* is found the peculiarity that the stalk has a joint in the middle; in *E. van Brunti* the globiferous pedicellariæ are very small, but otherwise of the common form. The tridentate pedicellariæ are narrowly leaf-shaped with little developed mesh-work (see Rev. of Ech. Pl. XXVI. Figs. 9, 12—13); in *van Brunti* they are of a quite different form, short, narrow, a little widened in the point, and the blade quite filled by a complicate mesh-work (Pl. XIX, Fig. 21). The ophicephalous pedicellariæ with a rather strong mesh-work, a little different in form, although upon the whole of the common structure; the triphyllous pedicellariæ of the common form. The spicules bihamate.

The genera *Heterocentrotus*, with the species *mamillatus* (Klein) and *trigonarius* (Lamk.), and *Colobocentrotus*, with the species *atratus* (L.) and *Mertensii* Br. are most nearly allied to *Echinometra*, as is commonly supposed; the globiferous pedicellariæ and the spicules are chiefly as in this genus. A primary tubercle is found on all the ambulacral plates; no ocular plate reaches to the periproct. The buccal membrane with numerous fenestrated plates several of which carry pedicellariæ and small spines as the buccal plates. The gills are in *Heterocentrotus* uncommonly well provided with fenestrated plates some of which even carry (triphyllous) pedicellariæ; rather numerous small bihamate spicules are also found among the fenestrated plates. In *Colobocentrotus* fewer fenestrated plates are found, but also here they carry triphyllous pedicellariæ. — Only in these two genera I have seen this peculiar feature that pedicellariæ are found on the gills. — In *Colobocentrotus* the globiferous pedicellariæ are quite small and placed quite down among the flat spines on the abactinal side; the edges of the blade not connected by cross-beams (Pl. XIX. Fig. 5). The stalk is curved. (In *C. Mertensii* I have not seen the globiferous pedicellariæ.) Of the tridentate pedicellariæ in *Heterocentrotus* Agassiz (Rev. of Ech. p. 665) has the remarkable expression that „the tridactyle pedicellariæ are of the type called trifoliate". I do not understand the sense of this expression; otherwise a rather good figure is given of these pedicellariæ in *H. mamillatus* (XXVI. Fig. 2). There is a striking difference between the tridentate pedicellariæ in *mamillatus* and *trigonarius*. In the former (Pl. XIX. Fig. 15) the blade is narrow in the lower part, widened at the point, with a pair of rather projecting corners; the valves only join at the point, and are otherwise wide apart; in *trigonarius* the blade is of the common leaf-shape (Pl. XIX. Fig. 35), with no widening at the point, and the valves join through their whole length. In both of them the edge is very slightly serrate, but there are some larger indentations in the narrow part of those of *mamillatus*. Perrier (op. cit.) thinks that several *Heterocentrotus*-species

[1]) Rech. sur les Pédicellaires etc. Pl. VI.

may be distinguished by the pedicellariæ; after the material before me I must agree with Agassiz that only two species can be distinguished: *mamillatus* and *trigonarius*. But then these two species may immediately be recognized by their tridentate pedicellariæ (besides by the characters stated by Agassiz [Rev. p. 427 seq.]). The tridentate pedicellariæ in *Coloboc. atratus* are very similar to those of *H. trigonarius*; the valves join through their whole length (Pl. XIX. Fig. 1); in *C. Mertensii* I have not succeeded in finding these pedicellariæ. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules are bihamate; in *Heterocentrotus* they are exceedingly numerous as well in tube feet as pedicellariæ, in *Coloboccntrotus* they are very few in number.

Of the forms referred to »*Triplechinidæ*» we have still left *Phymosoma crenulare* Ag., *Hemipedina cubensis* Ag., and *mirabilis* Död. None of these forms I have been able to examine, so that their place must for the present remain undecided. We may, however, draw same conclusions from the existing descriptions. Of *Phymosoma* Agassiz figures valves of globiferous and tridentate pedicellariæ (Rev. of Ech. Pl. XXV. 4, 5) from which is seen that no lateral teeth are found on the globiferous pedicellariæ; whether a neck is found or not is not mentioned. The spicules are not known. A peculiar feature is seen from the figures given by Agassiz (Rev. Pl. VII. a. f. 6, 8, 9), viz. that the pores form arcs with alternately two and three pairs. As the figures cited are photographs, there can be no doubt of their correctness, although Agassiz, as far as I can see, does not mention this fact. This peculiar feature together with the crenulate tubercles renders it undoubtful that this form has nothing to do with the genuine Echinids. Pomel (324) puts it down as the only recent representative of »Les Phymosomiens», and readopts the name of *Glyptocidaris*, by which it was originally described by Agassiz. I shall express no opinion whether it really is to be classed with »Les Phymosomiens», partly because my knowledge of these fossil forms is too small, partly because upon the whole I am rather sceptical with regard to the possibility of referring with certainty the recent forms to the fossil ones. Accordingly I agree with Pomel that the name of *Glyptocidaris* must be readopted for this form, as the name of *Phymosoma* has originally been used of fossil forms.

Of *Hemipedina cubensis* Ag. are figured (Rev. of Ech. Pl. III. f. 6–7) a tridentate pedicellaria and a smaller one which is stated to be a young tridentate pedicellaria, but which is rather a globiferous or ophicephalous one; neither is given with sufficient details. The spicules are not known. The perforated tubercles show, however, that this form has nothing to do at all with the other *Triplechinidæ*. Agassiz says himself that it is a Pseudodiadematid, but to refer all *Pseudodiadematidæ* to *Triplechinidæ* is by no means admissible, so much the less as these *Triplechinidæ* prove to be so heterogeneous that the genera referred thither must be distributed to three different families. Pomel (324) refers it to »Les Pediniens» as the only recent representative, and he readopts the name of *Cænopedina* by which Agassiz has originally described it. With regard to the name I must agree with Pomel for the same reasons as stated above under *Glyptocidaris crenularis*. I shall not contest that the referring to »Les Pediniens» is correct, but I must regard it as certain that it has nothing to do with »*Triplechinidæ*».

Having thus given a natural grouping of the species I shall have to treat the question of the grouping of the numerous genera. That the systems mentioned above, which are chiefly based on the number of the pairs of pores, give no impression of the real relation of the forms need not to be

pointed out more nearly. By an interpretation of the genera so confused as has been the case here, it is of course impossible to have a clear understanding of the relation between them. Of the characters hitherto used any greater importance can only be attributed to one, viz. the deep slits in the test (Troschel, Pomel). The genera with deep slits in the test prove to be all closely allied. But this character is no quite reliable one; partly it is a matter of degree whether a slit is deep or not, and especially there is the unfortunate circumstance that the slits are always small in young specimens, also in the species where they are deep in the adult ones; partly forms are found with small slits, which are, no doubt, most nearly allied to those with deep slits (*Gymnechinus*). Then we have left no other characters than the pedicellariæ and the spicules, but they prove also to be excellent. Of the pedicellariæ only the globiferous ones can be used for the grouping of the genera; the other pedicellariæ are upon the whole very similar in all the forms treated here.

The simplest form of globiferous pedicellariæ is evidently the one found in *Parechinus*; the blade is open, the edges are not connected by cross-beams, not thickened, and project in two or more rather long teeth on either side. A quite similar form is found in *Loxechinus*, only here a short neck is found, while *Parechinus* has no neck. — This form of pedicellariæ is only found in these two genera which form accordingly a separate group; they are very similar as to habitus, so that nothing seems to be found that might prevent a putting together of them. — A somewhat more complicate form is found in the genera *Echinus* and *Strongylechinus*. The edges of the blade are thickened, and are (with a single exception: *Strongyl. horridus* and [rarely] *Ech. Alexandri*) connected across the inside by more or fewer cross-beams. One or more lateral teeth are found on either side, most frequently there is a tendency to obliquity in the outer end of the blade, just below the end-tooth, and frequently there are two teeth on the stronger, a little projecting edge, and only one on the other, more straight edge. This form of pedicellariæ is only found in the two mentioned genera, and so they evidently form another group; also the forms belonging here show considerable similarity as to habitus. — A similar form of pedicellariæ is found, however, in one more genus, viz. *Paracentrotus*; also here the edges are thickened, with a tooth on either side, but they are not connected across the inside of the blade. It seems that this genus, which is polypore and, with regard to habitus, very different from the other genera mentioned here, must be interpreted as a somewhat farther relation of *Echinus* and *Strongylechinus*. In all these genera only simple bihamate spicules are found.

From these forms the development goes in two diverging directions: complete reduction of all the lateral teeth, or strong development of the one unpaired lateral tooth. In *Psammechinus*, *Toxopneustes*, *Gymnechinus*, *Tripneustes*, *Sphærechinus*, *Pseudoboletia*, and *Pseudocentrotus* all lateral teeth have disappeared, and the blade has become quite closed, tubular. Besides all these genera are distinguished by having small, thick, more or less dumb-bell-shaped spicules. There can be no doubt that they form a separate group. The three first have regularly trigeminate pores, in *Tripneustes* the young individuals have also regularly trigeminate pores, but in the adult the pore areas extend so much, that they look as if they were polypore; but they continue as a matter of fact to be oligopore. *Sphærechinus* and *Pseudoboletia* are polypore, mostly, however, with four pairs of pores in each arc. As the uppermost one in the series of development we find *Pseudocentrotus* with 5—6 pairs of pores where the pore areas are even somewhat petaloid on the actinal side.

The same form of globiferous pedicellariæ is found in *Strongylocentrotus*, *Anthocidaris*, and *Parasalenia*. The two former are distinguished by the globiferous pedicellariæ having a well developed neck, provided with circular and longitudinal muscles — an otherwise unknown feature. These three genera are likely to be rather nearly related; their spicules, however, show that the relation is not very close. In *Strongylocentrotus* the spicules are a little branched in the ends, but otherwise the original form is bihamate; in some species only (?) common bihamate spicules are found. In *Anthocidaris* the spicules are biacerate, pointed in both ends and with a branch in the middle. A somewhat similar form of spicules is found in *Parasalenia*; but in this genus the globiferous pedicellariæ have no neck. Thus this latter seems to form a special group; its obliquity and the peculiar anal plates indicate also that it must be interpreted as an aberrant form, of which the nearest, although not very near, relations are: *Anthocidaris* and *Strongylocentrotus*. In the genera *Heliocidaris*, *Echinostrephus*, *Toxocidaris*, *Echinometra*, *Heterocentrotus*, and *Colobocentrotus* there is a strong, unpaired lateral tooth on the globiferous pedicellariæ, and they have all simple bihamate spicules. *Heliocidaris* occupies a somewhat isolated position; its globiferous pedicellariæ are not so much developed as those of the other genera, it reminds to a rather high degree of *Sterechinus Neumayeri*, but especially of *Pseudechinus albocinctus*; several things favour the belief that *Pseudechinus* is really a transitional form between *Sterechinus* and *Heliocidaris*, and the latter leads on again to *Toxocidaris*, *Echinometra* etc. Thus we have here a very fine series of development where, together with the peculiar development of the globiferous pedicellariæ, a marked tendency to obliquity is seen, reaching the climax in the genera *Heterocentrotus* and *Colobocentrotus*. There seems to be no occasion to separate these two genera as a special group on account of their longitudinal axis not being placed in the same direction as in *Echinometra*, because their pedicellariæ and spicules are exactly agreeing with those of *Echinometra*. It is constantly seen that spicules and pedicellariæ are the most important systematic characters, so that there is no reason for suddenly following a new principle here. The genera *Pseudechinus*, *Heliocidaris*, and *Echinostrephus* must then be interpreted as more or less primitive oligopore Echinometrids.

Stomopneustes occupies a quite isolated position; its globiferous pedicellariæ and spicules are so peculiar and so different from what is found in the other forms mentioned here, that there can be no question of classing it with any of them; it forms a special group.

The relation between these forms may most easily be surveyed in the following diagram. For safety's sake I shall expressly remark, however, that I do not mean it to be regarded as a phylogenetic one. I will in no way maintain that our *Parechinus* is the ancestral form of *Echinus* etc., but only express my opinion that it shows the simplest structure of the organs most important with regard to classification. We may in the recent forms scarcely find more than an indication of the way the development seems to have taken. Now there is unfortunately only a small chance of finding these fine structures in the fossil forms, so we shall hardly get so far as to be able with certainty to point out the ancestral forms. Otherwise this survey of the relations of the forms shows clearly that here is everywhere a tendency to increase the number of tube feet, a development from oligopore to polypore forms. The most original feature, no doubt, is that all the ambulacral plates are well developed with primary spine and three tube feet; then the primary spines disappear from every other ambulacral

plate, and these plates become much narrower than the others, but keep their three tube feet. This development is carried on in *Tripneustes* and *Heliocidaris*, where the primary spine is wanting in more ambulacral plates after each other. By this development there is made room for far more tube feet than when all the ambulacral plates are typically developed and provided with a primary tubercle; but there are constantly only three tube feet for each compound ambulacral plate. The same end is reached by the fact that the ambulacral plates are made to consist of more than three primary plates, that they become polypore. In almost all the groups both oligopore and polypore forms prove to be found; only *Parasalenia* has no polypore relation, and in the *Strongylocentrotus*-group an oligopore form is still wanting. It may not be thought unreasonable to expect that such a one will be found; it is no far cry from *Str. pulcherrimus* where only four pairs of pores are found.

Pseudocentrotus
Pseudoboletia
Colobocentrotus
Anthocidaris Strongylocentrotus Sphærechinus Heterocentrotus
Tripneustes Echinometra
Toxopneustes Toxocidaris
Gymnechinus Echinostrephus
Parasalenia Psammechinus Heliocidaris
Pseudechinus
Paracentrotus
Sterechinus
Echinus
Loxechinus
Stomopneustes Parechinus

The result of the studies of *Echinometradæ* and *Triplechinidæ* represented here, is expressed in the following system.

Fam. **Stomopneustidæ** n. fam.

The spicules irregular, more or less tubular fenestrated plates. The globiferous pedicellariæ without end-tooth[1]) The stalk compact.

Only one genus known.

Stomopneustes Ag.

The pores trigeminate. Only every fourth or fifth ambulacral plate with primary tubercle, but this tubercle is large and spreads over several ambulacral plates. The spines long and thick; small spines on the buccal plates. The buccal membrane with numerous fine fenestrated plates, quite imbedded in the skin. The gills with numerous three-radiate spicules. A deep furrow along the median line in the interambulacral areas.

[1]) Perhaps here may be found, besides the large globiferous pedicellariæ without end-tooth (and without poison gland?), a smaller form of globiferous pedicellariæ of the common structure. (See above p. 126).

Species: *St. variolaris* (Lamk.), *atropurpurea* Woods (?).

Distribution: Indian Ocean, Australia. Littoral forms.

Fam. Echinidæ Ag. (emend.)

Spicules bihamate. The globiferous pedicellariæ with end-tooth and one or more lateral teeth on either side; no neck; the stalk consists of long, thin, loosely connected calcareous threads. Mouth slits small.

Subfam. **Parechininæ** n. subfam.

In the globiferous pedicellariæ the edges of the blade are fine, not thickened, and project into two or more teeth on either side. No cross-beams connect the edges across the inside of the blade.

Genera: *Parechinus*, *Loxechinus*.

Parechinus n. g.

Pores trigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fenestrated plates; they may be very large and thick, or finer and hidden in the skin. The globiferous pedicellariæ without neck. Numerous short, greenish spines.

Species: *Parech. miliaris* (Müll.), *microtuberculatus* (Blv.), *angulosus* (Leske).

Distribution: In the Atlantic Ocean at the European coasts, the Mediterranean; the southern and eastern coasts of Africa; the Indian Archipelago, Australia. Littoral forms.

Loxechinus Desor (emend.).

Pores multigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fenestrated plates. The globiferous pedicellariæ with a short neck only containing longitudinal muscles. Numerous short, greenish spines.

Species: *L. albus* (Mol.), *gibbosus* (Val.), *bullatus* (Bell).

Distribution: The southern and western coasts of South America, the Galapagos Islands[1]). Littoral forms.

Subfam. **Echininæ** n. subfam.

In the globiferous pedicellariæ the edges of the blade are thickened and commonly connected by cross-beams across the inside of the blade. One or more lateral teeth on either side.

Genera: *Echinus*, *Strerechinus*, *Paracentrotus*.

Echinus Rond. (emend.)

Pores trigeminate; primary tubercle on every or only on every other ambulacral plate. No ocular plate reaches to the periproct. The buccal membrane with numerous fenestrated plates imbedded in the skin both outside and inside of the buccal plates. The spines upon the whole long and strong; the actinal primary spines not curved at the point. Globiferous pedicellariæ generally with the edges connected across the inside of the blade. The large, generally long and narrow, tridentate pedicellariæ with thick edge upon which numerous small teeth are placed in transverse series or irregularly.

[1]) The occurrence of *L. albus* at the Philippines and of *gibbosus* at the Fiji Islands needs corroboration.

Species: *Ech. esculentus* L., *acutus* Lamk., *melo* Lamk., *elegans* Düb. Kor., *gracilis* Ag., *Alexandri* Dan. Kor., *lucidus* Döderl., *affinis* n. sp., *atlanticus* n. sp.

Distribution: The Atlantic Ocean, the Mediterranean, the Pacific Ocean. Littoral-archibenthal forms.

Sterechinus Koehler (emend.).

Pores trigeminate; primary tubercle on every or only on every other ambulacral plate. The buccal membrane most frequently with numerous fenestrated plates inside of the buccal plates, outside of these it is almost or quite naked. Generally one or more (all) of the ocular plates reach to the periproct. The secondary spines often fine, silky; the actinal primary spines curved at the point (always?). The globiferous pedicellariæ generally with the edges connected across the inside of the blade. The tridentate pedicellariæ broad, leaf-shaped; the edge not thickened, only with a single series of teeth.

Species: *Sterech. margaritaceus* (Lamk.), *horridus* (Ag.), *Neumayeri* (Meissn.), *magellanicus* (Phil.).

Distribution: The southern and western coasts of South America, the Antartic Seas. Littoral-archibenthal forms.

Paracentrotus n. g.

Pores multigeminate. Primary tubercle on all the ambulacral plates. The buccal membrane with fenestrated plates both inside and outside of the buccal plates (outside, however, rather few). None or 1—2 ocular plates reach to the periproct. The spines long and rather thick; the actinal ones not curved at the point. In the globiferous pedicellariæ the edges are not connected by cross-beams across the inside of the blade. The tridentate pedicellariæ long, narrow, without transverse series of small teeth.

Species: *Paracentr. lividus* (Lamk.), *Gaimardi* (Blainv.).

Distribution: The Mediterranean and the adjoining Atlantic coasts. Brazil. — Littoral forms.

Fam. **Toxopneustidæ** Troschel (emend.).

The globiferous pedicellariæ with end-tooth, but without lateral teeth; the edges of the blade quite coalesced on the inside, so that the blade is tubular. Peculiar dumb-bell-shaped or somewhat branched spicules are generally found in the globiferous pedicellariæ and often also in the tube feet; bihamate spicules are generally also found; in one form (*Strongylocentrotus pulcherrimus*) only bihamate spicules are known. Generally 1—2 ocular plates reach the periproct.

Subfam. **Schizechininæ** Pomel (emend).

The spicules in the globiferous pedicellariæ dumb-bell-shaped or small bows not pointed at the ends. Generally deep slits in the test. The globiferous pedicellariæ without neck; mostly with glands on the stalk. The stalk compact.

Genera: *Psammechinus*, *Gymnechinus*, *Toxopneustes*, *Tripneustes*, *Sphærechinus*, *Pseudoboletia*, *Pseudocentrotus*.

Psammechinus Ag. (emend.)

(Synonyms: *Lytechinus* Ag., *Psilechinus* Ltk., *Schizechinus* Pomel.)

Pores trigeminate; primary tubercle on all the ambulacral plates. Slits of the test rather deep. The buccal membrane with numerous plates forming a more or less distinct plate-covering. In the globiferous pedicellariæ the blade is not much lengthened. The spicules dumb-bell-shaped, form no border round the globiferous pedicellariæ. The spicules of the tube feet bihamate, not branched. The spines of a middle length, greenish.

Species: *Psammech. variegatus* (Lamk.), *semituberculatus* (Val.), *verruculatus* Ltk.

Distribution: The eastern and western coasts of tropical America; the Indian Ocean. Littoral forms.

Gymnechinus n. g.

Pores trigeminate; primary tubercle on all the ambulacral plates. Slits of the test small. The buccal membrane, with the exception of the buccal plates, contains no fenestrated plates at all. Inmost in the edge of the mouth more or fewer irregular, needle-shaped spicules are found; also numerous bihamate spicules are found, especially nearest to the edge of the mouth and the outer edge. In the globiferous pedicellariæ the blade is not much lengthened. The spicules of the globiferous pedicellariæ arcuate or slightly dumb-bell-shaped, form no border. Smaller, short-spined forms.

Species: *Gymnech. Robillardi* (Loriol), *darnleyensis* (Woods)[1].

Distribution: Mauritius, Australia. Littoral forms.

Toxopneustes Ag. (emend.).

(Synonym: *Boletia* Desor.)

Pores trigeminate; primary tubercle only on every other ambulacral plate. Slits of the test deep. The buccal membrane with numerous fenestrated plates most of which are quite imbedded in the skin. In the globiferous pedicellariæ the blade is much lengthened. The spicules in the globiferous pedicellariæ are typically dumb-bell-shaped and form a thick, white border round the outer edge of the valves; in the tube feet branched, bihamate spicules are found. Large, flat, short-spined forms.

Species: *T. pileolus* (Lamk.), *roseus* Ag., *elegans* Döderl.

Distribution: The Indo-Pacific Ocean. Littoral forms.

Tripneustes Ag. (emend.)

(Synonym: *Hipponoë* Gray.)

Pores trigeminate; primary tubercle only on every third or fourth ambulacral plate. The pore areas very broad, so that the pores form three separated vertical series; in the small individuals the pores are placed in the usual manner in short arcs. The buccal membrane with numerous fenestrated plates most of which are quite imbedded in the skin. Slits of the test rather deep. In the globiferous pedicellariæ the blade is not much lengthened; the pedicellariæ upon the whole small and darkly pigmented. The spicules in the globiferous pedicellariæ are typically dumb-bell-shaped; they form no border. The bihamate spicules in the tube feet are not branched. Large, high, short-spined forms.

[1] Comp. above p. 110.

Species: *Tripn. esculentus* (Leske), *depressus* Ag., *gratilla* (L.).

Distribution: Cosmopolitan in the warm zone. Littoral forms.

Sphærechinus Desor (emend.).

Pores multigeminate (generally four in each arc); primary tubercle on all the ambulacral plates[1]). Slits of the test rather deep; the buccal membrane with rather numerous fenestrated plates; no spines on these or on the buccal plates. In the globiferous pedicellariæ the blade is not much lengthened. The spicules of the globiferous pedicellariæ small bows, not pointed at the ends; they form no border. In the tube feet branched, bihamate spicules are found. Large, short-spined forms, almost globular.

Species: *Sphærech. granularis* (Lamk.), *roseus* Russo, *australiæ* Ag.

Distribution: The Mediterranean and the adjoining Atlantic coasts, Australia. Littoral forms.

Pseudoboletia Troschel (emend.).

Pores multigeminate (four in each arc); primary tubercle on all the ambulacral plates. Slits of the test rather deep. The buccal membrane with rather numerous plates carrying both spines and pedicellariæ; spines are likewise found on the buccal plates. In the globiferous pedicellariæ the blade is not much lengthened. The spicules of the globiferous pedicellariæ small bows, not pointed at the ends; they form no border. The bihamate spicules in the tube feet are not branched. Large, high, rather short-spined forms.

Species: *Ps. indiana* (Mich.), *maculata* Trosch.

Distribution: The Indo-Pacific Ocean. Littoral forms.

Pseudocentrotus n. g.

Pores multigeminate; primary tubercle on all the ambulacral plates. The pore areas somewhat petaloid on the actinal side. Slits of the test rather small. The buccal membrane with numerous fine fenestrated plates; no spines on these or on the buccal plates. In the globiferous pedicellariæ the blade is not much lengthened. The spicules of the globiferous pedicellariæ bow-shaped, not pointed at the ends; they form no border. The bihamate spicules in the tube feet are branched. The spines rather long and strong; the test rather flat.

Only one species known: *Ps. depressus* (Ag.).

Distribution: Japan. Littoral form.

Subfam. **Strongylocentrotinæ** n. subfam.

The spicules of the globiferous pedicellariæ bihamate (always?), generally branched at the ends; no dumb-bell-shaped spicules, nor such as are not pointed at the ends. The globiferous pedicellariæ with well developed neck with longitudinal and circular muscles; tubular stalk.

Genera: *Strongylocentrotus*, *Anthocidaris*.

Strongylocentrotus Brandt (emend.).

Pores multigeminate; the pore areas not petaloid on the actinal side. Primary tubercle on all the ambulacral plates. The buccal membrane with numerous fine fenestrated plates most of

[1]) Not examined in *Sph. australiæ*.

which are quite hidden in the skin. The spicules bihamate, branched or unbranched. The test more or less flattened. The spines very different, from short and fine to long and coarse ones.

Species: *Str. chlorocentrotus* Brandt, *pulcherrimus* (Barn.), *intermedius* (Barn.), *drobachiensis* (O. F. Müll.), *purpuratus* Stimps., *franciscanus* (Ag.).

Distribution: The Northern Atlantic, the Arctic Ocean (*drobachiensis*); the Northern Pacific Ocean (all the species). Littoral forms.

Anthocidaris Lütken (emend.).

Pores multigeminate; the pore areas somewhat petaloid on the actinal side. Primary tubercle on all the ambulacral areas. The buccal membrane with numerous fine fenestrated plates most of which are quite hidden in the skin. The spicules in the tube feet biacerate, a little curved, with a rather strong point in the middle of the convex side. The test somewhat flattened, the spines rather long and strong.

Only one species known: *A. homalostoma* Ltk.

Distribution: Japan, China. Littoral form.

Subfam. **Parasaleninæ** n. subfam.

The spicules of the globiferous pedicellariæ bihamate, unbranched; those in the tube feet biacerate with a couple of small processes on the concave side. The globiferous pedicellariæ without neck; the stalk compact. Slits of the test small[1]).

Only one genus known: *Parasalenia.*

Parasalenia Ag.

Pores trigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fine fenestrated plates; no spines on the buccal plates. The periproct covered by four large plates. The test oblong. The spines long and strong.

Species: *P. gratiosa* Ag., *Pöhlii* Pfeffer.

Distribution: The Indo-Pacific Ocean. Littoral forms.

Fam. **Echinometridæ** Gray (emend.)[2]).

The globiferous pedicellariæ with end-tooth and one unpaired, strong lateral tooth; the edges of the blade almost always connected by cross-beams across the inside; no neck. Only bihamate spicules are found. Slits of the test small. The stalk of the pedicellariæ compact.

Genera: *Pseudechinus*, *Heliocidaris*, *Echinostrephus*, *Toxocidaris*, *Echinometra*, *Colobocentrotus*, *Heterocentrotus.*

Pseudechinus n. g.

Pores trigeminate; primary tubercle on all the ambulacral plates. The buccal membrane quite naked with the exception of the buccal plates. The spines of a middle length, slender. The form of the test regular, *Echinus*-like.

[1]) *Parasalenia Pöhlii* not examined.

[2]) The name of *Echinometradæ* is linguistically incorrect (Bell).

Only one species: *Pseudech. albocinctus* (Hutton).

Distribution: New Zealand. Littoral form.

Heliocidaris Desml. (emend.)

(Synonym: *Evechinus* Verr.)

Pores trigeminate; primary tubercle only on every second or third ambulacral plate. The buccal membrane with numerous fine fenestrated plates hidden in the skin. No spines on the buccal plates. The triphyllous pedicellariæ with peculiar, digitate processes from the apophysis (in all the other genera the triphyllous pedicellariæ are constructed in the usual way). The spines short, strong, greenish; the secondary spines club-shaped. The form of the test regular, *Echinus*-like.

Species: *H. chloroticus* (Val.), *raritubercutatus* (Bell), *australiæ* Woods (? — not examined).

Distribution: New Zealand, Australia. Littoral forms.

Echinostrephus Ag. (emend.)

Pores trigeminate, more rarely quadrigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fenestrated plates, most of which carry pedicellariæ. No spines on the buccal plates. The form of the test very peculiar, flat and broad above, narrow below. The spines rather thin, black; those of the upper side long, directed straight upward.

Species: *Ech. molare* (Blv.), *pentagonus* Yosh. (? — not examined).

Distribution: The Indo-Pacific Ocean. Littoral forms.

Toxocidaris Ag. (emend.)

Pores multigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with rather few plates most of which carry pedicellariæ; no spines on the buccal plates. The form of the test regular, *Echinus*-like. The spines rather long and thick.

Species: *T. tuberculatus* (Lamk.), *erythrogrammus* (Val.), *armiger* (Ag.).

Distribution: Australia. Littoral forms.

Echinometra Rond. (emend.)

Pores multigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fine fenestrated plates hidden in the skin, of which only a few carry pedicellariæ. Spines on the buccal plates. The form of the test more or less oblong. The spines rather long and thick.

Species: *Ech. lucunter* (L.), *viridis* Ag., *Mathaei* (Blv.), *oblonga* (Blv.), *van Brunti* Ag., *macrostoma* (Ltk.) (?).

Distribution: Cosmopolitan in the warm zone. Littoral forms.

Heterocentrotus Brandt (emend.).

Pores multigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fenestrated plates, partly hidden in the skin. Spines both on the buccal plates and on some of the plates outside of these. The test oblong. The primary spines exceedingly large and thick, mostly edged; the secondary ones short, truncate.

Species: *H. mamillatus* (Klein), *trigonarius* (Lamk.).

Distribution: The Indo-Pacific Ocean. Littoral forms.

Colobocentrotus Brandt (emend.).

Pores multigeminate; primary tubercle on all the ambulacral plates. The pore areas on the actinal side petaloid. The buccal membrane with numerous fenestrated plates, partly hidden in the skin. Spines both on the buccal plates, and on some of the plates outside of these. The test oblong, flat. The spines very short, thick, truncate, form a dense mosaic on the abactinal side. The spines on the ambitus longer, flat; those on the actinal side of the common form.

Species: *C. atratus* (L.), *Mertensii* Brandt.

Distribution: The Indo-Pacific Ocean. Littoral forms.

Incertæ sedis:

Echinus multicolor Yoshiwara.

Toxopneustes maculatus (Lamk.).

Strongylocentrotus mexicanus (Ag.).

— *nudus* (Ag.).

— *globulosus* (Ag.).

The system given here is, I think, in all essentials an expression of the natural relation of these forms. To be sure, we must a priori hesitate before building up a system chiefly on so minute things as pedicellariæ and spicules. But the result is the best possible one: no undoubtedly connected forms are separated; on the other hand, forms hitherto placed very far from each other in spite of their great similarity as to habitus, are now put together (*Parechinus* and *Loxechinus*). That the boundary line in one place is somewhat arbitrary is no important objection to the system — this will be the fact everywhere, where transitional forms are found. The genus *Pseudechinus* is here referred to the *Echinometridæ*; but there can scarcely be any doubt that it is also closely allied to the *Echinidæ*, it seems especiallyto be a near relation of *Strerechinus magellanicus*. Here it has been referred to the *Echinometridæ* especially for practical reasons, it being then possible to give a quite certain character of these two families: in one teeth on either side of the blade of the globiferous pedicellariæ, in the other only one unpaired lateral tooth. *Pseudechinus* forms the connecting link between the two families, and it is especially worthy of notice that in this genus may sometimes be found an indication of a lateral tooth also on the other side of the blade of the globiferous pedicellariæ.

The family *Toxopneustidæ* is sharply limited from the other two families, without transitional forms. Objections can scarcely be raised against the subfamily *Schizechininæ* — all the genera referred thither, are evidently closely allied. Less sure are the subfamilies *Parasalenininæ* and *Strongylocentrotinæ*. Possibly the feature whether the globiferous pedicellariæ have a neck or not, is not of so great importance, as has here been supposed; but I think it impossible to decide this fact with certainty, as long as only so few forms belonging here are known.

That no other outer characters are found in these forms, which may be used in the classification, I think to be certain; both the test and the spines have been studied rather thoroughly, so that anything new of importance is scarcely to be expected here. It is hardly probable that the inner anatomical structure will yield systematic characters of any greater importance, but this question, at

all events, deserves a closer examination. There is, however, one feature left, from which important contributions to the classification may be expected, viz. the larval forms. As almost all the species belonging here, are littoral forms, they may all be supposed to have pelagic larvæ, and they will, no doubt, show a great richness in forms. That the larva of *Sphærechinus* is so different from those of *Echinus*[1]) indicates, at all events, that very interesting things may be found here.

Fam. Echinidæ.

Subfam. **Parechininæ.**

11. **Parechinus miliaris** (Müll.).

Pl. II. Fig. 7. Pl. XV. Figs. 6—7, 11. Pl. XVI. Fig. 15. Pl. XVII. Figs. 1—2, 7—8, 10—11, 14—15, 22—28.

Principal synonyms: *Echinus miliaris* Müll.
Psammechinus miliaris (Lamk.).
Echinus saxatilis O. F. Müll.
— *virens* Düb. Kor.

Principal literature: Düben & Koren: Öfversigt af Skandinaviens Echinodermer. p. 274. — Agassiz: Revision of Echini. p. 495. — Hoyle: Revised List of Brit. Echinoidea (202). p. 417. — Bell: Catalogue of Brit. Echinoderms. p. 150. With regard to the other extensive literature the reader is especially referred to Bell's Catalogue.

It is not necessary to give a thorough description of this well known species, I shall only refer to the works cited above. On Pl. II. Fig. 7 is given a coloured figure of the animal; with regard to the test I shall refer to Pl. XV. Figs. 6—7, 11, where the apical area, an ambulacral and an interambulacral area are represented. From these figures it is clearly seen that the secondary tubercles form no regular longitudinal or transverse series, and that a primary tubercle is found on all the ambulacral plates. The buccal membrane is richly provided with large, thick, irregular plates, between which the naked skin is seen, especially on dried specimens; they are constructed as usual (Pl. XVI. Fig. 15; the figure represents one of the simplest plates from the outer edge of the peristome), contrary to what is the fact in *P. microtuberculatus* (Pl. XVI. Fig. 14) where they consist of a compact, greenish calcareous mass with funnel-shaped holes. The plates inside of the buccal plates are somewhat smaller than those outside and constructed in a far simpler way; they consist only of one layer with some knobs on the upper side. The buccal plates carry numerous pedicellariæ, but no spines. The gills contain small irregular calcareous plates.

The pedicellariæ. The globiferous pedicellariæ (Pl. XVII. Figs. 1, 7, 23—24) are generally exceedingly numerous, and form, as it were, a dense, white flue, especially on the abactinal side. The blade is rather broad and flat, and the edges not connected by cross-beams across the inside. The edges are not thickened, and project into — generally — 7—8 long, somewhat irregular indentations; the number may vary between 5 and 10. There are often some more on one side than on the other. The stalk

[1]) Th. Mortensen: Die Echinodermenlarven der Plankton-Expedition. Ergebn. d. Plankton-Exped. d. Humboldtstiftung. II. J. 1898.

consists of long, thin calcareous threads connected by small cross-beams. — Perrier[1]) states that the valves of the globiferous pedicellariæ end in two hooks «situés sur le même plan». This is absolutely wrong; I suppose he must have interpreted the edges of the poison canal as two separate teeth. The tridentate pedicellariæ (Pl. XVII. Figs. 2, 11, 22) with rather broad, not very deep blade; the outer part, where the valves join, is somewhat widened and sinuate in the edge. The whole edge is serrate, coarsely below, finely above, but there is only a single series of teeth, they form no transverse series as in the *Echinus*-species. The bottom of the blade is filled by a rather well developed net of meshes. The apophysis has 2—4 rather large indentations at the upper end. The valves are rather wide apart through the greater part of their length. In larger specimens tridentate pedicellariæ are also found on the buccal plates; they are smaller than the others, more spoon-shaped; the edge more straight, and there is no mesh-work at the bottom (Fig. 2). According to Perrier (loc. cit.) the apophysis of the tridentate pedicellariæ is «découpé en un nombre assez grand de dents pointues»; as stated above I have only found 2—4 teeth. The ophicephalous pedicellariæ show no marked peculiarities; the blade is rather narrow, with well developed mesh-work (Pl. XVII. Figs. 8, 28). The triphyllous pedicellariæ (Pl. XVII. Figs. 14, 25) are distingnished by the very finely rounded form of the blade. — The sphæridiæ (Pl. XVII. Figs. 26, 27) are quite smooth.

The spicules in the tube feet are very few, often quite wanting. They are bihamate, very small (Pl. XVII. Fig. 10); just below the sucking disk they may be a little irregular. The spicules figured by Perrier as belonging to this species, no doubt belong to *Strongylocentrotus drobachiensis*. — There are no bihamate spicules in the gills or the buccal membrane, nor in the pedicellariæ or in the skin at the base of the spines.

It is a small species; a specimen of a diameter of 35^{mm} is uncommonly large. It is very common in the Danish seas, quite down in the western part of the Baltic but not in the eastern part. Along the coasts of Norway it is common, at all events to Trondhjem; further it is found at Iceland and the Faroe Islands, but not at Greenland or North America. To the south it is found at the coasts of Great Britain and along the Atlantic coasts of Europe quite down to Morocco. Bell (Catalogue. p. 151) states that it is also found in the Mediterranean.

It is a pronounced littoral form, often found just at the beach; but it is common down to ca. 50 fathoms, and may be found on still greater depths. At the Faroe Islands I have taken a large specimen on a depth of 100 fathoms; this fact, however, is a little uncertain. The locality is a little range of the sound between Nolso and Ostnæs; it is not impossible that the dredge has got in on more shallow water at the edge of this deep hole, so that the animal may have been obtained there. It prefers hard, stony bottom.

Subfam. **Echininæ.**

12. **Echinus elegans** Düb. Kor.

Pl. I. Figs. 2—3. Pl. III. Fig. 4. Pl. XV. Fig. 4. Pl. XVI. Figs. 3, 19. Pl. XVIII. Figs. 2, 3, 22, 26. Pl. XIX. Figs. 10, 26. Pl. XX. Figs. 8, 9, 19, 22, 23.

Synonym: *Echinus Wallisi* Ag. (?)

Principal literature: Düben & Koren: Öfvers. af Skandinaviens Echinodermer. p. 272. —

[1]) Recherches sur les Pédicellaires. p. 146. Pl. V.

Agassiz: Revision of Echini. p. 491. — Wyv. Thomson: Echinoidea of Porcupine (395) p. 744. — Hoyle: Rev. List of Brit. Echinoidea (202) p. 414. — Bell: Catalogue of Brit. Echinoderms. p. 154.

The form of the test rather varying, from evenly rounded to slightly conical, on the actinal side evenly rounded or almost flat (in the conical forms); the edge of the mouth always somewhat bent inward. The peristome rather large. The height of the test a little more than half the diameter; the contour round.

The ambulacral areas (Pl. XVI. Fig. 19) a little more than half as broad as the interambulacral ones, at the edge of the mouth generally a little broader than the latter. The number of ambulacral plates is rather constant, one third as great as that of the interambulacral plates. The boundaries between the primary plates generally somewhat indistinct; the boundary line between the areas not much sinuate. The arcs of pores rather steep; the pores reach quite to the edge. Sometimes four

Diameter.	Height.	Diameter.		Largest breadth.		Number of plates.		Longest spines.
		Peristome.	Periproct.	Ambulacral area.	I.-Ambulacral area.	Ambulacral area.	I.-Ambulacral area.	
51	27	17	5	11	20	27—28	17—18	
46	24	17	5·5	10·5	18	23—24	15—16	23[1]
37	20	14·5	4·2	8·2	14·2	21—22	14—15	
35	21	13·3	4	7·8	14	21	14	
31	18	12	3·5					20
30	18	13	4·5	7	11	18—19	12—13	19[2]

All the measures are in millimetres.

pairs of pores are found in an arc. The primary tubercles are rather large and strong, somewhat smaller than the interambulacral ones, and form a very conspicuous, uninterrupted longitudinal series, a primary tubercle being found on all the plates. They are placed very close together, the edges of their scrobicular areas join through almost the whole area only the very uppermost ones are separated. This fact of the tubercles being placed so close together gives to the test a very characteristic appearance. The secondary tubercles may form a short longitudinal series on the actinal side inside of the primary series, but this feature is not a constant one. On the abactinal side there are only few secondary tubercles; commonly there is one small tubercle between the pores and the primary tubercle. Miliary tubercles numerous and rather strong; together with the secondary ones they give the whole test a very rough and uneven appearance. (In the figures the miliary tubercles have been omitted.)

The interambulacral areas (Pl. XV. Fig. 4). Also here the primary tubercles form a very close series, the scrobicular areas, however, do not join above the ambitus. The secondary tubercles are very numerous on the actinal side; they are considerably smaller than the primary ones, and form no distinct longitudinal series neither inside nor outside of the primary ones.

The apical plates carry rather many tubercles (Pl. XVI. Fig. 3). The periproct is generally very small (in the figured one it was larger than is commonly the fact), covered by numerous, irregular

[1] The specimen figured on Pl. I. Fig. 2.
[2] The specimen figured on Pl. I. Fig. 3.

small plates; here and here a tubercle may be found on a somewhat larger plate. Nearest to the anal opening the small plates are a little lengthened.

The buccal membrane commonly richly provided with large, simple fenestrated plates as in *Ech. Alexandri*; those inside of the buccal plates also as in this species. Bihamate spicules may be found in rather great number among the fenestrated plates. A few of the plates outside of the buccal plates are larger and somewhat complicate, and carry pedicellariæ. No spines on the buccal plates.

The spines of a middle length, $^1/_2$—$^2/_3$ of the diameter of the test, rather strong; they are largest at the ambitus, but decrease generally only little towards the apical area. The actinal primary spines may be truncate and flat at the point (not constantly), not irregularly widened as in *Ech. acutus*.

The pedicellariæ are generally very numerous, especially the ophicephalous ones. The globiferous ones (Pl. XVIII. Figs. 2—3) have most frequently 2—3 teeth on either side of the blade, sometimes 3 or only one on one side, two on the other. The basal part has often a few indentations in the edge, but this is no constant feature. The stalk is rather strong and may at the upper end have some thorns directed downward (Pl. XX. Fig. 23). The tridentate pedicellariæ (Pl. XVIII. Figs. 22, 26. Pl. XX. Fig. 9): the valves rather broad, a little widened at the point, where they join; the edge is here rather sinuate, in the other part it is straight, thick, and set with small teeth forming somewhat irregular transverse series. There is a rather well developed mesh-work at the bottom of the blade. — Together with this form is often found a smaller one (Pl. XX. Fig. 9), where the blade is almost quite flat and rather abruptly truncate at the point, without mesh-work. In some specimens only this form is found. Transitional forms between this form and the larger one are found, so that it cannot be regarded as another kind than the larger form. — The ophicephalous (Pl. XIX. Fig. 10) and the triphyllous pedicellariæ (Pl. XX. Fig. 22) show no marked peculiarities. — The sphæridiæ (Pl. XIX. Fig. 26) are generally somewhat grooved and thorny; the grooves often form rather distinct longitudinal series. The spicules (Pl. XX. Fig. 8) are small and rather varying in form. They are pretty numerous in the tube feet and gills; in the skin round the base of the spines some spicules are generally found, and sometimes a few are found in the stalks of the pedicellariæ (the globiferous ones).

The typical coloration is as on Pl. III. Fig. 4: purple, white-tipped spines; the test white, slightly rosy round the apical area (Pl. I. Fig. 3). In some of the specimens in hand this colour, however, is only slightly indicated; some are quite white, others have only a slight yellowish red tint around the apical area or only at the base of some of the primary tubercles on the abactinal side. In one specimen the test is of a fine lilac colour (Pl. I. Fig. 2).

Ingolf	St. 1	(62° 30′ N. L.	8° 21′ W. L.	142	fathoms,	Sand, Shells.	Bottom temp.	7° 8).	1	spec.
—	— 47	(61° 32′	— 13° 40′	— 950	—	Mud.	—	3° 1).	3	—
—	— 52	(63° 57′	— 13° 32′	— 420		?	—	7° 2).	2	—
—	— 54	(63° 08′	— 15° 40′	— 691	—	?	—	4° 2).	6	—

This species is indigenous in the sublittoral-archibenthal zone of the northern Atlantic, both at the European and American side, as well as south of Iceland, and in the sea along Norway; it is found on ca. 50—950 fathoms. The statement that it goes down to 1350 fathoms (Challenger-

Echinoidea p. 115) is incorrect (see below). Agassiz (»Challenger»-Echinoidea p. 213) states that it is also found in the Mediterranean, off Tristan d'Acunha and Papua (more exactly: the Admiralty Islands), and these statements are adopted by Hoyle and Bell. I cannot dispute the occurrence in the Mediterranean, as I have not seen the specimens upon which the statement rests; on the other hand I must maintain that the other statements are incorrect, as I have examined the specimens from »Challenger» that Agassiz has determined as *Ech. elegans* (Chall. Ech. p. 115). The specimen from st. 46 (south of Nova Scotia, 1350 fathoms) is a large, fine specimen of *Ech. Alexandri*. Those from Tristan d'Acunha are likewise a large, fine form, very similar to *Ech. Alexandri* (the more long-spined forms). Its narrow tridentate pedicellariæ, however, show that it cannot be this species; presumably it is a new species, which seems to be most closely allied to *Ech. lucidus* Döderl. The specimens from st. 219 (the Admiralty Islands), on the other hand, are something widely different from *Ech. elegans*. There is an unpaired lateral tooth on the globiferous pedicellariæ, and according to my observations by the short examination during my stay at British Museum I feel inclined to think that it is nearly related to *Arbacina forbesiana*; at all events it is a sure fact that it has nothing to do with *Ech. elegans*, and upon the whole does not belong to the family *Echinidæ*.

Thus a great uncertainty is seen to have been prevailing with regard to the interpretation of this species. The description of *Ech. elegans* given by Agassiz in »Rev. of Ech.», does not agree with this species, but with *Ech. norvegicus*, and the figure given (Pl. VII. a. Fig. 4) seems also to be *Ech. norvegicus*; it is not, however, to be seen with certainty, as the specimen has been less well preserved. — In conformity to this wrong interpretation of *Ech. elegans* Agassiz seems to have established a new species, *Ech. Wallisi*, for the real *Ech. elegans*. As mentioned above (p. 100) I have received a specimen from U. S. National Museum, determined as *Ech. Wallisi*, which is no doubt a large specimen of *Ech. elegans*, only a little more short-spined than is usually the case. But I think it must be regarded as a little doubtful, whether it is really *Ech. Wallisi*. It does not agree very well with the description of this species, especially must be pointed out that its pores are trigeminate as usual in *Echinus*. But, according to Agassiz *Ech. Wallisi* is distinguished by »the arrangement of the pairs of pores in sets of two» («Blake»-Echini p. 39). — It is impossible for me to decide how the fact really is, but to judge by this specimen it is a sure fact that *Ech. elegans* is found off North America, and that *Ech. Wallisi* is either synonymous with it — but then its pores are trigeminate and not in »sets of two» — or that it is a separate species with the pores in »sets of two», but then it is no *Echinus*. At all events it is to be regretted that Agassiz has given a so deficient description of a new species, and, moreover, has not given any figure of it at all.

Judging from the material of *Ech. elegans* we have from the Ingolf-Expedition, it is a very varying form. If we compare the test of a subconical and a higher form, we might be led to suppose them to be two separate species. But transitional forms are found, and especially no difference seems to be found in the pedicellariæ. For the present I must regard them all as one species, but the possibility is not excluded that by means of a larger material we may be able to distinguish different forms. It is, however, I think, more likely that it will show a richness in forms similar to that of *Echinus Alexandri*, in which case the Challenger-specimens from Tristan d'Acunha will perhaps nevertheless have to be referred to *Ech. elegans*.

13. **Echinus Alexandri** Dan. Kor.

Pl. V. Figs. 2—3, 5—7. Pl. XV. Figs. 13, 17. Pl. XVI. Fig. 8. Pl. XVIII. Figs. 9, 11, 19, 23, 25. Pl. XIX. Figs. 16, 31, 34, 38. Pl. XX. Figs. 1, 2, 27. Pl. XXI. Figs. 18—20, 27.

Literature: Danielssen & Koren (109). — Danielssen (110): Echinida. Norske Nordhavs-exped. p. 1. T. I. — Koehler (224—226): Echinodermes. Caudan. p. 92. Pl. I. fig. 4 Pl. II. fig. 18—19.

Of this large, fine species we have a very great material from the Ingolf, and as I have had the type specimen of Danielssen for examination, I have been able to identify it with certainty. Prof. Koehler has further sent me some of his specimens from Caudan, so that I am also able to corroborate the correctness of his determination. On the basis of this great material I shall then give a new description of the species.

The test is much flattened, the height generally a little less than half the diameter of the test; specimens of a middle size and smaller ones are quite flat above, the larger ones a little rounded. The actinal side is flat, not at all or very little curved inward at the edge of the mouth. The slits as usual small and rather indistinct.

Diameter.	Height.	Diameter.		Largest breadth.		Number of plates.		Longest spines.
		Peristome.	Apical area.	Ambulacral area.	Interambulacral area.	Ambulacral area.	Interambulacral area.	
69	35	19·5	10	13	29	23—24	15—16	c. 50
68	35	19	9					c. 50
62	30	19	10	12	26	24—25	15—16	
45	21	15	6·5					22
45	24	14	5·5					43
38	17	13	5					25
34	15·5	12·5	?	7	13·5	16—17	12—13	
31	15	10·5	4·5	6·8	12	16—17	13—14	
30	14	11	5					34
30	14·5	10	4·5					22
19	9	8	3					15
14	6·5	5·5	2·5					14
13	5·5	6	3	3	5	11	9	

All the measures in millimetres.

The ambulacral areas (Pl. XV. Fig. 13) in large specimens scarcely half as broad as the interambulacral areas, in smaller specimens a little more than half this breadth; at the edge of the mouth the two areas are of about equal breadth. The number of compound plates in the ambulacral areas is only about $^1/_2$—$^1/_3$ time greater than that of the interambulacral areas, accordingly the ambulacral plates are rather high. The arcs of pores are not placed very obliquely, in small specimens they are almost perpendicular. In the type specimen the arcs of pores show a remarkable irregularity, as is seen in the figures of Danielssen. As no similar feature is seen in any of the Ingolf-specimens it is no doubt something abnormal. The pores reach quite to the edge of the plates. The boundaries between the small plates rather indistinct, the boundary line between the areas rather highly sinuate. The primary tubercles form a very conspicuous, dense longitudinal series; a primary tubercle is found

on all the ambulacral plates. The scrobicular areas join on the actinal side as far as to the ambitus. On the abactinal side the primary tubercles decrease very much in size. The secondary tubercles form at the ambitus a tolerably distinct longitudinal series inside of the primary one, but they are considerably smaller than the primary tubercles. There are generally a couple of small tubercles just inside of each arc of pores. Besides numerous small tubercles are found on the actinal side, a few ones on the abactinal side.

The interambulacral areas (Pl. XV. Fig. 17). The primary tubercles form a strong, uninterrupted longitudinal series, but the scrobicular areas do not touch each other on the actinal side; on this side they are only little larger than the ambulacral primary tubercles, on the abactinal side considerably larger. In large specimens they decrease only very little in size towards the apical area, in smaller specimens, on the other hand, they decrease very much in size, so that the whole abactinal side gets a strikingly smooth and naked appearance, the secondary tubercles being here also very few. The actinal side is closely set with secondary tubercles forming a distinct longitudinal series inside of the primary one, and the tubercles of this series may be almost as large as the primary ones. Outside of the primary series the secondary tubercles are scattered, not placed in longitudinal series. The miliary tubercles are generally few in number and little conspicuous, so that they do not deprive the abactinal side of its smooth character.

The apical area (Pl. XVI. Fig. 8) is most frequently somewhat raised, especially the inner edge. The form of the apical plates show no peculiarities; there is generally a circle of tubercles along the inner edge. In some specimens two pores may be found in one or a couple of the genital plates. The periproct is rather large, covered by numerous small, irregular plates, among which the central plate may be distinct; the plates nearest to the anal opening are a little lengthened, thick, irregularly club-shaped. On specimens in alcohol only these knobs are seen nearest to the anal opening, so that it looks as if the other part of the periproct were naked (Koehler 226. p. 94); in dried specimens the whole area is distinctly seen to be covered with small plates. — In the description by Danielssen the curious expression occurs: the membranous portion (periprocte) is closely covered with round calcareous vessels; this, no doubt, is owing to the fact that an erratum in the Danish text, Kalkkar in stead of Kalkkorn, has passed into the English text, which has thus got the meaningless expression calcareous vessels in stead of calcareous grains.

The buccal membrane contains numerous large, thin, highly perforated calcareous plates (Pl. XXI. Fig. 27); those inside of the buccal plates are much smaller and almost without holes (Pl. XXI. Fig. 18. a). There is a slight indication of a radiate arrangement of the inmost plates. Very few or no bihamate spicules in the buccal membrane. No spines on the buccal plates; only in larger specimens a few pedicellariæ are found outside the buccal plates. The gills with the usual irregular calcareous plates and a few bihamate spicules.

The length of the spines is very varying, as is seen from the noted measures; thus in two specimens of a diameter of 45^{mm} the longest spines in one specimen are 22^{mm}, in the other 43^{mm}. In some specimens the spines are even longer than the diameter of the test, as is especially seen in the statements of Koehler. All the specimens of Koehler seem to have been long-spined: among those from the Ingolf only a few long-spined specimens are found (especially from st. 78), in most

of them the spines are somewhat shorter than the diameter of the test, in some specimens even only half so long. In conformity to the size of the tubercles the spines on the ambulacral areas are a little shorter than those of the interambulacral areas. The actinal spines are blunt, a little flat, but not widened at the point. In the more long-spined specimens the primary spines decrease only little in length towards the apical area, in the specimens with shorter spines those at the ambitus are considerably longer than the others.

The pedicellariæ are most frequently rather few, especially the globiferous and tridentate ones, sometimes one or the other, or even both of these forms are quite wanting in large specimens. The globiferous pedicellariæ (Pl. XVIII. Figs. 9, 11) have commonly 3—4 teeth on either side of the blade; the number is, however, varying from 2—5 teeth, and there is often an unequal number on the two sides. The edges of the blade are commonly connected by some cross-beams, but sometimes they are not connected at all, as in the type specimen (Fig. 9). That this feature can be of no greater importance here, so that it might be used as a specific character, is sure enough, as in the same pedicellaria one valve may be found with the edges of the blade connected by cross-beams, while in the others the edges are not connected. Generally, however, the edges are connected, as shown in Fig. 11. The basal part may be finely rounded, or with a single indentation in the edge; the apophysis is most commonly a little serrate in the edge. In the type specimen the upper end of the apophysis has a peculiar form which I have not found quite similar in other specimens.

The tridentate pedicellariæ (Pl. XVIII. Figs. 23, 25. Pl. XIX. Figs. 34, 38. Pl. XX. Fig. 1. Pl. XXI. Fig. 20) are very different from those of the other *Echinus*-species. The valves are broad, rather flat, without mesh-work at the bottom (except just at the end of the apophysis); they are full of holes regularly arranged in beautiful arcs. The edges are often somewhat bent inward in the lower part, where the valves are apart (Pl. XVIII. Fig. 23); in the outer part, where the valves join, the edge is rather coarsely sinuate. The edges are thick, set with transverse series of small teeth; in the outer part these small teeth are numerous and not placed in transverse series (Pl. XXI. Fig. 20). Generally these pedicellariæ are rather large, up to 2·5^{mm}, but quite small forms may also be found, as the one figured on Pl. XIX. Fig. 38. — Danielssen has not found the tridentate pedicellariæ in the type specimen; the figure with regard to which Koehler supposes that it might be a tridentate pedicellaria (Fig. 9), is a globiferous one, and even a tolerably good figure (Koehler has found no globiferous pedicellariæ in his specimens). The tridentate pedicellariæ are, however, also found in the type specimen; I have found a few ones, all rather small; on Pl. XIX. Fig. 34 is figured a valve of one of these pedicellariæ. They are broad and flat as in the other specimens, only the edge is not curved inward in the lower part; this feature, however, is of no great importance, as in the same specimen some pedicellariæ may be found with inward bent, others with straight edge. As such broad, tridentate pedicellariæ are not found in any other *Echinus*-species, they are of great importance for the determination of this species. Unfortunately they are not rarely wanting.

The ophicephalous pedicellariæ (Pl. XIX. Fig. 16) are generally very sinuate in the edge; the mesh-work in the blade is not much developed. In some specimens together with this common form another larger, more lengthened form is found with many serrations in the edge and well developed mesh-work in the blade (Pl. XX. Fig. 27); they may be almost as large as the tridentate pedicellariæ.

All transitional forms are found between this large form and the small, common form, and the specimens in which they are found, agree otherwise exactly with the other specimens, so that there can be no question of interpreting them as a separate species, not even as a separate variety.

In the triphyllous pedicellariæ (Pl. XVIII. Fig. 19) the upper edge of the apophysis is most frequently a little arched over the blade, which is somewhat broader than usual; this feature is, however, scarcely to be regarded as a constant, reliable character. — The sphæridiæ (Pl. XIX. Fig. 31) have some small spines at the end, no grooves. Spicules (Pl. XX. Fig. 2) of the common form. With regard to the colour I may refer to the beautiful figure by Koehler (226. Pl. I. Fig. 4).

«Ingolf» st.	7	(63° 13′	N. L.	15° 42′	W. L.	597	fathoms.	Hard clay.		Bot. temp.	4° 9).	8	spcms.	
—	42	(61° 41′	—	10° 17′	—	625	—	Sand		—	1°).	5	—	(1 doubtf.)[1]
—	43	(61° 42′	—	10° 11′	—	645	—	—		—	0° 7).	11	—	
—	44	(61° 42′	—	9° 36′	—	545	—	Hard bottom.		—	5° 4).	15	—	
—	46	(61° 32′	—	11° 35′	—	720	—	Gray mud with stones.		—	2° 3).	40	—	(6 doubtf.)
—	47	(61° 32′	—	13° 40′	—	950	—	Mud with Globigerina.		—	3° 1).	80	—	(40 —)
—	49	(62° 07′	—	15° 08′	—	1120	—	?		—	3° 3).	4	—	
—	52	(63° 57′	—	13° 32′	—	420	—	?		—	7° 2).	14	—	
—	53	(63° 15′	—	15° 07′	—	795	—	?		—	3° 0).	68	—	(45 doubtf.)
—	54	(63° 08′	—	15° 40′	—	691	—	?		—	4° 2).	10	—	
—	64	(62° 06′	—	19° 00′	—	1041	—	?		—	3° 1).	4	—	(1 doubtf.)
—	65	(61° 33′	—	19° 00′	—	1089	—	Mud.		—	3° 3).	13	—	(2 —)
—	78	(60° 37′	—	27° 52′	—	799	—	—		—	4° 1).	3	—	
—	93	(64° 36′	—	34° 50′	—	767	—	?		—	1° 3).	1	—	
—	95	(65° 14′	—	30° 39′	—	752	—	?		—	1° 7).	6	—	
—	96	(65° 24′	—	29° 00′	—	735	—	?		—	0° 9).	3	—	

From previous collections we have further a few specimens from 65° 39′ N. L. 28° 25′ W. L. 553 fathoms (Ryder), and from 60° 32′ N. L. 4° 20′ W. L. 525 fathoms (Wandel). — It has further been taken by «Challenger» off Cape Cod and the Bay of Maine, 1350 fathoms (st. 46), one specimen from this locality, by Agassiz referred to *Ech. elegans* (Chall. Ech. p. 115), proving to be this species. By «Caudan» it has been taken in the Bay of Biscay. Thus there can be no doubt that this species is found in the archibenthal zone of the whole northern Atlantic; that it has not been mentioned before is, doubtless, not owing to its not having been found there by the earlier expeditions, but to the fact that it has been confounded with other species, *elegans* and, presumably, especially with *norvegicus*. — Otherwise the ridge between Iceland and the Faroe Islands does not form the northern boundary of this species, any more than of *Ech. elegans*. To be sure only one specimen is known from the Norwegian Sea, but this is, moreover, taken on a place, where the bottom temperature was negative (st. 176. Norwegian North-Sea Exped. 69° 18′ N. L. 14° 33′ E. L. 536 fathoms. Bottom temperature −0·2). This, however, is certainly an exception; the mentioned station is just at the edge of the large, cold depth of the Norwegian Sea. It is, no doubt, distributed on the smaller depths along the coast of Norway, but in the cold area it certainly is not found.

[1] The specimens here noted as «doubtful», are young ones, not yet showing the specific characters so distinctly developed, that it can be decided with certainty, whether they belong to this species or to *E. affinis* (see below p. 152).

14. **Echinus affinis** n. sp.

Pl. V. Figs. 4, 8. Pl. XV. Figs. 3, 10. Pl. XVI. Figs. 6, 20. Pl. XVIII. Figs. 4, 16, 28. Pl. XIX. Fig. 27. Pl. XX. Figs. 17, 21.

This species resembles much *Ech. Alexandri*, together with which it is often found; a closer examination shows, however, that several good characters are found distinguishing it from this species. The test is generally evenly rounded on the abactinal side, but it may be almost as flattened as in *Alexandri*. The actinal side is generally less flat than in the latter species; the edge somewhat curved inwardly; the peristome rather large.

Diameter.	Height.	Diameter.		Largest breadth.		Number of plates.	
		Peristome.	Apical area.	Ambulacral area.	Interambulacral area.	Ambulacral area.	Interambulacral area.
38	22	12	5·5	8	16	20—21	14—15
36	21	12	5·2	8	15	19—20	14—15
26	13	9	5	5·1	10·2	17—18	12—13
24	13	8·8	4	5	10	16—17	12—13

All the measures in millimetres.

The ambulacral areas (Pl. XV. Fig. 10. Pl. XVI. Fig. 20) generally half as broad as the interambulacral ones; at the edge of the mouth they are of equal breadth. There are $^1/_3$–$^1/_2$ time as many ambulacral as interambulacral plates; in proportion to the size the number is a little larger than in *Alexandri*. The arcs of pores are rather erect, they do not always reach quite to the edge of the area. The boundaries between the small plates rather indistinct, the boundary line between the areas somewhat sinuate. A primary tubercle is found on all the ambulacral plates, but they show a very peculiar arrangement. In some specimens the two series are about equally strong, but then they are both very irregular, large and small primary tubercles occurring among each other without any order (Pl. XV. Fig. 10). It reminds much of *Ech. norvegicus* (Pl. XV. Fig. 16); but in the latter the principal series is formed by both primary and secondary tubercles, while in *Ech. affinis* it is formed by primary tubercles alone, as is sufficiently shown by their position. In other specimens the tubercles decrease evenly in size towards the peristome and the apical area, but then the two series of the same area are of very different size (Pl. XVI. Fig. 20). The largest primary tubercles are not much smaller than those of the interambulacral areas. The secondary tubercles are very few and almost only found on the actinal side; they are small and form no longitudinal series.

The interambulacral areas (Pl. XV. Fig. 3). The primary tubercles are large and strong; they decrease almost not at all in size towards the apical area, but in the common way down towards the mouth. The scrobicular areas scarcely touch each other on the actinal side, on the abactinal side the distance between them is considerable, the plates being rather high. The secondary tubercles are very few on the abactinal side, which has a similar naked appearance as in *Ech. Alexandri*. On the actinal side they are numerous, but form no regular longitudinal series inside or outside of the primary series, and they are far from equalling the primary tubercles as to size. The miliary tubercles are generally little numerous; in some specimens, however, they may be so conspicuous as to deprive the test of its smooth appearance.

The apical area (Pl. XVI. Fig. 6) is generally somewhat raised, but otherwise of the common form; also here sometimes two pores may be found in one genital plate, as in the figure. Only 2—3 tubercles on each genital plate, one or none on the ocular plates. The periproct rather large, covered by numerous small, more or less knob-shaped plates assuming towards the anus a somewhat lengthened form. No distinct central plate.

The buccal membrane with numerous fine fenestrated plates of the same form as in *Ech. Alexandri*, sometimes also with rather many bihamate spicules. There are no spines on the buccal plates, and none or very few pedicellariæ outside of these. The gills with the usual irregular fenestrated plates and most frequently rather numerous bihamate spicules.

The spines are long and strong, but hardly so much varying in length as in *Ech. Alexandri*; exact informations of this fact cannot be given, as the spines are broken on the specimens in hand (when they are not quite rubbed away). The actinal spines are not broad and flat at the point.

The pedicellariæ are generally not numerous, especially the tridentate and globiferous ones, and as in the preceding species one or other of these forms may be quite wanting. The globiferous pedicellariæ (Pl. XVIII. Fig. 16) have generally 2—2 lateral teeth, more rarely 3 teeth; sometimes only one tooth is found on one side. Otherwise they show no constant difference from those of *Ech. Alexandri*. Rather numerous cross-beams seem always to be found between the edges of the blade. The tridentate pedicellariæ (Pl. XVIII. Figs. 4, 28) are very different from those of the preceding species; the blade is very long, narrow, and deep with a rather well developed system of beams at the bottom. The apophysis at its upper end spreads into a large perforated plate; most frequently a narrow, irregular prolongation passes from it some way into the blade, being placed a little deeper than the plate. The edge is as usual provided with transverse series of small teeth, perhaps a little less numerous than in *Ech. Alexandri*. The valves are very wide apart, only joining for a little way at the point, which is a little obliquely cut off; in this part the edge is slightly sinuate. The length of the head up to 2·2^{mm}. The ophicephalous pedicellariæ chiefly of the same form as in the preceding species, only the indentations being perhaps a little less developed; the peculiar lengthened form that may be found in *Ech. Alexandri*, I have not found in this species. The triphyllous pedicellariæ (Pl. XX. Fig. 21) of the common form. The sphæridiæ (Pl. XIX. Fig. 27) as in the preceding species, but with fewer spines at the point, often quite smooth. The spicules (Pl. XX. Fig. 17) are pretty varying in form; they are rather numerous in tube feet and gills, and sometimes in the buccal membrane; at the base of the spines no spicules are found.

I can give no information of the natural colour of this species; all the specimens in hand are quite bleached both on the test and the spines. It reaches scarcely to so considerable a size as *Ech. Alexandri*.

Ingolf»	st. 46	(61° 32′	N. L.	11° 35′	W. L.	720	fms.	Gray mud with stones.	Bottom temp.	2° 8).	8 spcms.
—	- 47	(61° 32′	—	13° 40′	—	950	—	Mud with Globigerina.	—	3° 1).	31 —
—	- 49	(62° 07′	—	15° 08′	—	1120	—	?	—	3° 3).	7 —
—	- 50	(62° 43′	—	15° 07′	—	1020	—	Mud.	—	3° 0).	3 —
—	- 52	(63° 57′	—	13° 32′	—	420	—	?	—	7° 2).	2 —
—	- 53	(63° 15′	—	15° 07′	—	795	—	?	—	3° 0).	2 —
—	- 64	(62° 06′	—	19° 00′	—	1041	—	?	—	3° 1).	10 —
—	- 65	(61° 33′	—	19° 00′	—	1089	—	Mud.	—	3° 3).	26 —

Accordingly the species has been taken in considerable numbers and on many localities, and so it would be a remarkable fact, if it had not been taken before by any deep-sea Expedition. It has also been taken, and surely numbers of times; it has only been confounded with other species. I am able to substantiate the following instances: From U. S. Fish Commission (Smithsonian Institution) our museum has received 4 specimens under the name of *Echinus norvegicus*; they are typical *Ech. affinis*. («Albatross». 1884. 39° 35′ N. L. 71° 24′ W. L. 1043 fathoms.) In «Challenger»-Echinoidea *Ech. norvegicus* is mentioned from sts. 46 and 47 (eastern coast of North America, off Cape Cod); it is also *Ech. affinis*. (On st. 46 it is taken together with *Ech. Alexandri*, comp. p. 149). Accordingly there can be no doubt that this species like *Ech. Alexandri* is found throughout the archibenthal zone of the northern Atlantic, and possibly it is still wider distributed. In «Challenger»-Echinoidea *Echinus acutus* is mentioned from st. 170, off the Kermadec Islands in the Pacific Ocean. After having examined the specimen from this station in British Museum, I must positively assert that it is no *Ech. acutus*; on the contrary it agrees with *Ech. affinis* with regard to the tubercles of the ambulacral areas and the pedicellariæ, and I have found no character, by which it might be distinguished from *Ech. affinis*. Accordingly I must regard it as a rather sure fact that it is *Ech. affinis*; a more thorough examination will, however, be necessary in order to establish the fact definitively. — North of the ridges between the Faroe Islands and Iceland, and between Iceland and Greenland it has not been found, and at all events it is surely not found in the cold depth of the Norwegian Sea.

The species *Ech. Alexandri* and *affinis*, no doubt, are closely allied. As they are most frequently found together, it is an obvious thought that they might possibly be one species with a marked difference of sex, although such a difference is otherwise very unusual in the Echinids. Of this, however, there can be no question, as I have found both ♀ and ♂ among specimens of *affinis*. There can be no doubt that they are two well distinguished species. The form of the test, the tubercles on the ambulacral areas, and especially the tridentate pedicellariæ yield excellent criterions of them. But on the other hand it may be very difficult or quite impossible to distinguish quite young individuals of the two species, the more important specific characters being not yet typically developed. From the «Ingolf» we have thus a rather great number of small specimens, which I am not able with certainty to refer to one or the other of the two species. They are badly preserved, so that no tridentate pedicellariæ are to be found. These pedicellariæ are otherwise early developed, and give then all desirable certainty in the determination. The tridentate pedicellariæ seem not rarely to be quite wanting in larger individuals, as may also be the case in *Ech. Alexandri*; the determination of such specimens will, however, scarcely cause any difficulty, as especially the arrangement of the tubercles in the ambulacral areas then will be a sufficient criterion.

15. **Echinus acutus** Lamk.

Pl. I. Figs. 4, 7—8. Pl. II. Figs. 1—2, 6, 8. Pl. XV. Figs. 2, 14—16. Pl. XVI. Figs. 2, 5, 10, 16, 18, 22. Pl. XVIII. Figs. 1, 5—7, 14, 24. Pl. XIX. Figs. 32, 36. Pl. XXI. Figs. 25—26.

Principal synonyms: *Echinus Flemingii* Forb.

— *norvegicus* Düb. Kor.

— *depressus* G. O. Sars.

Echinus rarispinus G. O. Sars.
— *microstoma* Wyv. Thoms.

Principal literature: Düben & Koren: Öfvers. af Skandinaviens Echinodermer. p. 266, 268. — M. Sars: Norges Echinodermer. p. 92. Middelhavets Littoral-Fauna. p. 111. — G. O. Sars: Nye Echinodermer fra den norske Kyst (Vidensk. Selsk. Forhandl. Kristiania. 1871. p. 23). Bidrag til Kundskaben om Dyrelivet paa vore Havbanker. Ibid. 1872. p. 104. — Agassiz: Revision of Echini. p. 296, 489. 6. p. 77. Blake Echini (9). p. 39. — Wyv. Thomson: Porcupine Echinoidea (395). p. 744. — Danielssen: Echinida. Norske Nordh. Exped. (110). p. 3. — E. v. Marenzeller: 269. p. 13. 270. p. 20. — Koehler: 217. p. 121. Notes échinologiques (221). p. 20. 229. p. 23. — Prouho: 327. p. 8. — Hoyle: Revised List of Brit. Echinoidea (202). p. 413, 415. — Bell: Catalogue of Brit. Echinoderms. p. 146—49. With regard to the other literature the reader is referred to Revison of Echini, Bell's Catalogue, and Ludwig's Die Echinodermen des Mittelmeeres (256).

This species, I think, is the one that has caused most difficulties to the systematists. As shown by the synonyms enumerated above, a whole series of species has been established on more or less distinct forms of it; some of these, however, are now commonly regarded as synonyms, while others (*norvegicus*, *microstoma*, and partly *Flemingii*) are constantly mentioned as independent species, although expressions as critical species (Wyv. Thomson. Op. cit.), it seems almost hopeless to attempt to distinguish the species of *Echinus* known as *E. elegans*[1]), *E. norvegicus*, *E. melo*, and *E. Flemingii* (Agassiz 9. p. 39) sufficiently show the difficulty of distinguishing between them. The best founded of these species is, no doubt, *norvegicus*, and so long as I had only examined the material from the Ingolf-Expedition, and what was otherwise found in our museum of this form, I also felt persuaded that it was a distinct species. After having collected a considerable material at the Faroe Islands during the summer of 1899, and especially after having received a considerable number of specimens of all sizes from the Mediterranean from Prof. E. v. Marenzeller, I have got to the result, however, that the whole can only be interpreted as one very varying species, among the numerous forms of which three tolerably distinct varieties may, however, be distinguished: var. *mediterranea*, *Flemingii*, and *norvegicus*.

The northern specimens are generally easily referred to respectively *norvegicus* or *Flemingii*: especially it seems that at the Norwegian coasts specimens are rather seldom found, which are only with difficulty decidedly to be referred to one or the other of the mentioned forms. Most of the mentioned specimens from the Faroe Islands, on the other hand, it was impossible with certainty to refer to one or the other variety. In the Mediterranean a third, very large form occurs, which I have called var. *mediterranea*; it does not seem to be found in the northern Atlantic, but in return var. *Flemingii* is apparently not found in the Mediterranean. On the other hand var. *norvegicus* occurs in both seas. But in the Mediterranean this latter scarcely occurs as a marked variety; in the material received from Prof. v. Marenzeller, at all events, all possible transitions were found between the genuine *norvegicus* and var. *mediterranea*. In the first of the essays quoted above v. Marenzeller has referred the specimens before him to *E. norvegicus* after a comparison with northern specimens of this form; in the latter he has, on the basis of a greater material, referred the whole to *Ech. acutus*. I must

[1]) That *E. elegans* is mentioned in this connection is owing to a wrong interpretation of this species (comp. pp. 99, 145).

decidedly follow v. Marenzeller in this, and further draw the consequence of it (what has not expressly been done by v. Marenzeller), viz. that *Ech. norvegicus* becomes synonymous with *Ech. acutus*.

I shall here give the characters of the three most marked forms or varieties; but it is expressly to be observed that all possible transitional forms are found, so that it will often be impossible to decide, to which of these varieties some particular specimens are to be referred.

Var. *mediterranea* (Pl. II. Fig. 8. Pl. XV. Figs. 14—15. Pl. XVIII. Figs. 5—6. Pl. XIX. Fig. 36). The test high, conical, or more globular, somewhat flat, however, on the actinal side. The peristome rather small, with the edge somewhat curved inward. The tubercles very small, considerably smaller than in var. *Flemingii* (comp. Pl. XV. Fig. 15 with Pl. XVI. Fig. 2; both figures are drawn in natural size, the former [var. *mediterranea*] accordingly from a much larger specimen than the latter [var. *Flemingii*]). As usual they are largest at the ambitus, and decrease evenly in size towards the mouth and the apical area. The primary tubercles of the ambulacral areas form regular longitudinal series, but, apart from some smaller irregularities, they are only found on every other ambulacral plate; the secondary tubercles form no distinct longitudinal series. In a considerable part of the middle of the test the pores recede not a little from the outer edge of the area, leaving a very distinct naked space between the pores and the edge, generally quite without spines. The primary tubercles of the interambulacral areas are somewhat larger than the ambulacral ones; also here they are not rarely wanting on every other plate for a longer or shorter way on the abactinal side. The secondary tubercles are small and rather few; on the actinal side some of them are almost as large as the primary ones, and form a tolerably distinct longitudinal series inside of the primary series, and in the largest specimen in hand one more series is indicated inside of these. The tubercles outside of the primary series are placed quite irregularly.

The spines on the abactinal side are rather few, short, and thin, those at the ambitus, however, being longer and stronger; the latter are directed downwards like those on the actinal side, and they are of such a length, that all the spines on the lower side reach equally far down with the point so as to produce a quite even ambulatory surface (Pl. II. Fig. 8); they are truncate, flat, and widened at the point. The colour of the test is reddish, with more or less distinct, white stripes between the series of tubercles; the actinal side white. The spines on the abactinal side are most frequently red or reddish brown at the base, and white in the other part; of the actinal spines the outer ones are also red at the base, and then white for a greater or smaller part, but thereupon a greater part of the point is deep red, which gives to the animal a very peculiar appearance (Pl. II. Fig. 8). The innermost ones, nearest the mouth, are quite white.

Var. *Flemingii* (Pl. I. Fig. 7. Pl. II. Fig. 1. Pl. XVI. Figs. 2, 10, 16, 18. Pl. XVIII. Fig. 14. Pl. XIX. Fig. 32. Pl. XXI. Figs. 25—26). The test most frequently somewhat conical, sometimes more flat; the actinal side rather flat, the edge of the mouth only slightly bent inward; the peristome rather large.

The tubercles large and strong. A primary tubercle is only found on every other ambulacral plate; the plates where it is wanting, have generally two strong secondary tubercles, one out at the pores, and one nearer the median end, accordingly one on either side of the primary series of tubercles. Most frequently every other plate is regularly wanting a primary tubercle, but it may be wanting in

2—3 or still more plates in succession. This, however, does not make the primary series look very irregular. The secondary tubercles are very few; on the actinal side the largest ones form a rather regular longitudinal series on either side inside of the primary series; here they almost equal the primary tubercles in size. The pores reach quite to the edge of the area.

The primary tubercles of the interambulacral areas are considerably larger than the ambulacral ones; they form very conspicuous longitudinal series. The tubercles are largest at the ambitus, but often they decrease only very little in size towards the apical area, but in the common way towards the peristome. Most frequently a primary tubercle is wanting on a few or more plates near the apical area; in the latter case, the plates, as in the ambulacral areas, are placed alternately with plates provided with a primary tubercle. The secondary tubercles are rather few on the abactinal side, and averagely much smaller than the primary ones; on the actinal side they are more numerous, and the largest are of about the same size as the primary tubercles; they form a rather regular longitudinal series inside of the primary one, and on large specimens one more series may be found inside, along the very median line of the area, not, however, very regular. The tubercles outside of the primary series form no longitudinal series. The miliary tubercles are rather numerous, but very small, so that the test looks rather smooth.

The spines are not very numerous, nor very close-set, but upon the whole long and strong — considerable variation is found, however, with regard to the size. The longest ones are found a little above the ambitus; in some individuals they decrease only very little in size towards the apical area, so that the uppermost spines are of about the same length as those at the ambitus, which gives to the animal a very peculiar appearance. On the actinal side the ends of the spines, as in var. *mediterranea*, form an even ambulatory surface; they are likewise flat, almost all of them, truncate, and a little widened at the point.

The colour of the test is white with a more or less broad, reddish brown band down the middle of each series of plates (Pl. I. Fig. 7). The lower side most frequently quite white. The spines are red, reddish brown, or greenish brown for a smaller part at the base, the rest white; the actinal spines are quite white. In younger specimens the red colour may reach almost to the point of the spines.

Var. *norvegicus* (Pl. I. Figs. 4, 8. Pl. II. Figs. 2, 6. Pl. XV. Figs. 2, 16. Pl. XVI. Figs. 5, 22. Pl. XVIII. Figs. 1, 7, 24). The test generally much flattened, in larger specimens slightly conical. The peristome highly varying in size, sometimes very small; the edge of the peristome generally much bent inward. The tubercles rather large and strong.

The ambulacral areas are very characteristic (Pl. XV. Fig. 16. Pl. XVI. Fig. 22). The primary tubercles form no continuous series; between every two plates with a primary tubercle one or more (up to 4, most frequently 2) plates are found without such a tubercle. On these latter plates (those above the ambitus) generally only one secondary tubercle is found, placed a little outside of the primary series, and this secondary tubercle is most frequently rather large, almost as large as the nearest primary tubercles. As a consequence of this feature the primary and secondary tubercles form together one longitudinal series, which is very irregular, partly because the tubercles do not decrease evenly in size upward, partly because they are not placed in a straight line. On the actinal side the

primary tubercles form a more regular series, the secondary tubercles being here considerably smaller than the primary ones, so that they here only to a smaller degree or not at all contribute to the formation of the series of tubercles, and here often more plates in succession have a primary tubercle. The pores reach quite to the edge of the area.

The primary tubercles of the interambulacral areas (Pl. XV. Fig. 2) form a very conspicuous longitudinal series, in large specimens sometimes with a few interruptions near the apical area. The secondary tubercles are very few and small on the abactinal side; on the actinal side, as usual, they are more numerous, and some of them become almost as large as the primary tubercles. In larger specimens they often, but not always, form a longitudinal series inside of the primary one; generally they are much larger in one series of plates than in the other. Those outside of the primary series are, as usual, smaller, but more numerous; in smaller specimens they are generally arranged in a rather distinct longitudinal series, in larger specimens most frequently irregularly placed.

The spines are on the abactinal side rather few; they are long and pointed, especially in small specimens, the interambulacral ones considerably longer than the ambulacral ones, corresponding to the mutual relation of the sizes of the tubercles. On the actinal side they are, as usual, more close-set, and, as in the two other forms, they are flat and widened at the point. The primary spines on the abactinal side decrease only little in length towards the apical area; on the actinal side they decrease very much in length towards the peristome; they do not, however, here form so fine, even an ambulatory surface as in the two other forms.

The colour of the test is in small specimens often very characteristic (Pl. I. Fig. 8. Pl. II. Fig. 6). There are 5 large, red spots on the interambulacral areas, and 5 narrow ones on the ambulacral areas, the boundaries between the areas are white. The spots reach to the ambitus, the actinal side is white. On the apical area there is most frequently a rather regular, white pentagon whose corners are formed by the ocular plates; thus the genital plates are white in the inner part, red in the outer part (with the genital pore). The periproct generally slightly reddish (this coloration of the apical area occurs also often in var. *Flemingii*). In larger specimens (Pl. I. Fig. 4) the red spots often spread over the whole abactinal side and some way down on the actinal side. The spines (Pl. II. Fig. 2) are generally red or reddish brown on a larger or smaller part at the base; this colour passes evenly into a greenish, at last slightly yellowish green colour. Often the spines are red in their whole length, especially the ambulacral ones. On the actinal side the spines are more whitish or quite white; in small specimens (Pl. II. Fig. 6) the spines are only slightly coloured.

Beyond the features described here scarcely any character of greater importance for the distinguishing of the three forms can be mentioned. Therefore I shall treat the other features together.

The apical area (Pl. XVI. Figs. 5, 10) without marked peculiarities; in larger specimens rather numerous tubercles are most frequently found, arranged circularly along the inner edge of the genital plates. The periproct covered by numerous small plates the largest of which carry a small tubercle.

The size of the peristome is very varying, especially in var. *norvegicus*. The buccal membrane is smooth, but contains rather numerous simple fenestrated plates among which more or fewer bihamate spicules may be found; the plates inside of the buccal plates are smaller, a little more

complicate (Pl. XVI. Fig. 16), and the innost ones show a radiate arrangement. There are no spines on the buccal plates; a few pedicellariæ may be found on the buccal membrane, especially opposite to the gills.

The pedicellariæ. The globiferous pedicellariæ (Pl. XVIII. Figs. 6, 24) have one lateral tooth on either side, sometimes two teeth on one side, one tooth on the other; the blade is almost tubular, the edges being coalesced to such a degree, that only a series of small holes are left in the median line, and one larger hole just below the large end-tooth. The basal part is very varying in form, with more or less projecting outer corners or with quite rounded edge. The apophysis is narrow and often rather irregular in the edge with a larger, oblong or rhombic hole at the upper end. The size differs very much; especially in var. *Flemingii* quite small pedicellariæ may be found. In var. *norvegicus* numerous spicules are generally found in the stalk and head of the globiferous pedicellariæ (also in the neck of the other pedicellariæ). The tridentate pedicellariæ (Pl. XVIII. Figs. 1, 5, 7). The valves long, narrow, and deep; the upper end of the apophysis spreads somewhat, and forms a little mesh-work in the lower end of the blade; a few narrow cross-beams cross the inside of the blade for a shorter or longer way. The edge is straight, thick, and set with numerous small teeth, placed in transverse series (Pl. XXI. Fig. 25); in the short part at the point where the valves join, the edge is more or less coarsely serrate. They may be very long, up to 2·5^{mm} (the length of the head). The ophicephalous pedicellariæ (Pl. XIX. Fig. 36) as well as the triphyllous ones without any characteristic peculiarities. — The sphæridiæ (Pl. XIX. Fig. 32) rather much grooved at the point. — The spicules (Pl. XVIII. Fig. 14) of the common form, numerous, especially in the abactinal tube feet; they are also found in rather great numbers in the skin round the base of the spines, and even some way out on the spines, in the gills, and in the buccal membrane: in the gills together with the common irregular fenestrated plates. Also in the pedicellariæ they may be found, especially in var. *norvegicus*. Sometimes a few S-shaped spicules may be found among the common bihamate ones.

Synonymous with this species are *Echinus rarispinus* G. O. Sars, *depressus* G. O. Sars, and *microstoma* Wyv. Thomson. The two former have already in Rev. of Ech. by Agassiz correctly been referred to *Ech. norvegicus*. Of *Ech. rarispinus* Danielssen (110. p. 4) says that if it be no distinct species it is at all events a well-marked variety that seems to work its way up to an independent species. By the kindness of Prof. Collett I have from the museum of Christiania got some typical specimens of *Ech. rarispinus* for examination; I can see no other thing but that they are large specimens of var. *norvegicus*. Pl. II. Fig. 2 may so far be taken as an *Ech. rarispinus*, but there is no reason to keep up this form as a special variety. Neither can I feel quite persuaded that the small specimens with the characteristic red spots (Pl. II. Fig. 6) may be said to be representatives of a dwarfish variety degenerated by its confined life in the fjords (Danielssen loc. cit.), as it is a fact that it is not confined to the fjords, but is also found in the midst of the Cattegat and Skager Rack; also from the Mediterranean and from the Bay of Biscay I have seen quite typical specimens. They are scarcely anything else than young specimens of *Ech. acutus*. It is, however, to be observed that such small specimens of a diameter of ca. $^1/_2$" may be sexually ripe, as pointed out by G. O. Sars[1]), and as I have also substantiated on specimens from the Cattegat. We have no proof that these small,

[1]) Forhandl. i Vidensk. Selsk. Christiania. 1872. p. 106.

sexually ripe individuals later grow to become large *Ech. acutus* of one or another form. Upon the whole we know next to nothing of the biology of these animals.

Echinus microstoma Wyv. Thomson (395. p. 744), of which Prof. Bell has sent me a couple of specimens, is only by its uncommonly small peristome distinguished from *Ech. acutus* var. *norvegicus*, in all the other respects it agrees completely with this latter. As there is, however, great variation with regard to the size of the peristome in *norvegicus*, I can in *Ech. microstoma* see nothing but a good *norvegicus*. The strong red colour and the thinness of the test, pointed out by Wyv. Thomson and Bell (Catalogue p. 149) as characters of *Ech. microstoma*, are as well found in typical *norvegicus*.

Whether *Ech. melo* can be kept up as a distinct species, I do not venture to say with certainty, as I have only had a slight material of it for examination; but I am inclined also to regard this form as a mere variety of *Ech. acutus*. Large specimens, to be sure, are very characteristic; but this holds also good with regard to *Ech. acutus* var. *mediterranea*, and I think it to be very doubtful, whether the smaller specimens may be distinguished with certainty. Koehler (221) has exactly enumerated the characters by which *Ech. acutus* and *melo* are distinguished. The most important one is the fact that in *melo* only every other interambulacral plate above the ambitus has a primary tubercle, while in *acutus* they have all such a tubercle — with the exception of the part near the apical area, where it is also wanting on every other plate; in some specimens the latter arrangement may even reach down almost to the ambitus. Thus this character is rather unreliable. Koehler finds another character of importance in the tridentate pedicellariæ, the edge of which is in *melo* highly serrate, in *acutus* almost smooth. According to my examinations, however, this feature is not at all constant; they may be thorny also in *acutus* and smooth in *melo*. (The thorns are in reality transverse series of small teeth, as usual in the *Echinus*-species). The other characters pointed out by Koehler, seem to me to be of slight importance. I may further mention that the globiferous pedicellariæ (Pl. XVIII. Fig. 18) are most frequently distinguished by the apophysis being peculiarly rugged or spinous above, and that the spicules are somewhat larger than usual (Pl. XVIII. Fig. 8). As in *acutus* a primary tubercle is only found on every other ambulacral plate, in several places even on every third plate only, and as in *Ech. acutus* var. *mediterranea* the pores are rather much removed from the edge of the ambulacral area. — Thus I can see no one character by which *Ech. melo* is decidedly distinguished from *acutus*, and accordingly it can scarcely be maintained as a distinct species, but only as a variety of *acutus*, characterized by its almost globular form, its green spines, and the peculiar coloration of the test.

Of *Ech. acutus* we have a rather great number of specimens, all of var. *norvegicus*, or at all events more nearly belonging to this variety, from the following stations (on the southern and western side of Iceland, the Denmark Strait):

St. 8	(63° 56′ N. L.	24° 40′ W. L.	136 fms.	Bottom temp.	6° 4).	1 specimen.
9	(64° 18′	27° 00′	295		6° 2).	2
16	(65° 28′	27° 05′	250		6° 4).	1
52	(63° 57′	13° 32′	420		7° 2).	2
54	(63° 08′	15° 40′	691		4° 2).	23
85	(63° 22′	25° 21′	170		?).	1
87	(65 02′	23° 58′	110		?).	1
98	(65 37′	26° 27′	138		6 2).	1

Further it has been taken on 63° 30′ N. L. 13° 39′ W. L. 92 fathoms (Wandel. 1890).

Otherwise this species occurs in the North-European seas up to north of Norway, at the British coasts, along South Europe into the Mediterranean; whether it is also found at the Azores is for the present uncertain (Koehler. 229. p. 23). It is found on depths between ca. 20— ca. 700 fathoms. Although in the Norwegian North Sea Expedition it is noted from a couple of stations with negative bottom temperature, its home must doubtless be said to be the warmer regions with positive bottom temperature. It does not occur in the cold area of the Norwegian Sea.

According to the statements given in the literature it is much wider distributed, is cosmopolitan, and ranges to a depth of 2435 fathoms (Chall. Ech. p. 213—14). As has already repeatedly been shown above, many of these statements are founded on wrong determinations, and to judge by these there is all probability that also the other statements, according to which *Ech. acutus* (or *norvegicus*) is said to occur outside of the territory stated above, are founded on wrong determinations. The places from which it is mentioned are: the eastern coast of North America to Florida, Ascension, the western coast of Patagonia, the Kermadec Islands, and Japan. As to the occurrence at the Atlantic coasts of North America, I cannot, of course, control the numerous statements of *Ech. norvegicus* being found there; but the specimens that our museum has received from U. S. National Museum under the name of *Ech. norvegicus*, at all events, are not this species, but *Ech. affinis*, and the statements in Chall. Ech. p. 117 that *Ech. norvegicus* has been taken on sts. 46 and 47 (off Cape Cod) are also founded on wrong determinations, what I have had occasion to substantiate during my stay at British Museum — these specimens are also *Ech. affinis*. Also *Ech. acutus* is in Chall. Ech. (p. 115) mentioned from the same place (st. 46); to be sure, I have not seen the specimens upon which this statement is founded, but considering how it is with *Ech. norvegicus* from the same station, and as the statement of *Ech. elegans* being found at the same place is also founded on a wrong determination (it is *Ech. Alexandri*), I think it best to remain sceptical with regard to *Ech. acutus* from st. 46 — and upon the whole with regard to all statements of the occurrence of this species off North America. The specimens from Ascension (Chall. st. 343) referred by Agassiz to *Ech. acutus* belong to another, new species, described above (p. 100) by the name of *Ech. atlanticus*.

From the western coast of Patagonia (Chall. st. 308) Agassiz mentions *Ech. norvegicus*; in British Museum I have seen the specimens upon which this statement is founded; they are two different species, viz. *Strechinus magellanicus* and an *Echinus*-species, probably a new one, but at all events closely allied to *Ech. elegans*, accordingly belonging to another group of species than *Ech. acutus*. From the Kermadec Islands (Chall. st. 170) *Ech. acutus* is mentioned; it is a large, fine specimen of *Ech. affinis*, as far as I was able to decide by a short examination; at all events it has nothing to do with *Ech. acutus*. With regard to the occurrence of this species at Japan, finally, *Ech. norvegicus* is in Chall. Ech. (p. 117) mentioned from this locality (sts. 232 and 235); I have seen two specimens from st. 232, which are, no doubt, *Ech. lucidus* Döderl. No more than all the above mentioned specimens they have anything to do with *Ech. norvegicus*. I have not seen the specimens from st. 235, but there can, I think, scarcely be any doubt that they are the same species as those from st. 232. — With this I think that the pretended enormous distribution of *Ech. acutus* is refuted. As far as we hitherto know, it occurs only in the North-European seas and the Mediterranean.

16. Echinus esculentus L.

Pl. I. Fig. 9. Pl. III. Fig. 3. Pl. XV. Figs. 1, 5. Pl. XVI. Figs. 7, 12. Pl. XVIII. Figs. 12, 13, 20. Pl. XIX. Figs. 24, 28, 30. Pl. XX. Figs. 24, 30.

Principal synonyms: *Echinus sphæra* O. F. Müller.

— *Schwartzii* Nilsson & Holst.

Principal literature: Sv. Nilsson & A. L. Holst: Collectanea Zoologiæ scandinavicæ. Lund. 1817. p. 7. — Düben & Koren: Öfvers. af Skandinaviens Echinodermer. p. 264. — Sars: Norges Echinodermer. p. 93. — Agassiz: Revision of Echini. p. 491. — Lovén: Echinoidea descr. by Linnæus (252). p. 61. — Hoyle: Rev. List of Brit. Echinoidea (202) p. 411. — Bell: Catalogue of Brit. Echinoderms. p. 152.

With regard to the other synonyms and the other literature I shall refer to Rev. of Ech. and Bell's Catalogue. — I shall not here give any thorough description of this well known and easily recognizable species, but only mention a few features which have hitherto been overlooked or not clearly described.

The primary tubercles are very small, both in the ambulacral and the interambulacral areas, so that they are only by a closer inspection seen also in this species to form regular longitudinal series in the interambulacral areas, even in the largest specimens (Pl. XV. Fig. 5). In small specimens, on the other hand, the primary tubercles form very conspicuous longitudinal series, both in the ambulacral and the interambulacral areas (Pl. I. Fig. 9), secondary tubercles being almost not yet found here. The series of primary tubercles in the ambulacral areas is in large specimens very indistinct (Pl. XV. Fig. 1); a primary tubercle is only found on every other ambulacral plate, below (and in young specimens) the alternation of the tubercles, however, is most frequently very irregular, and above the ambitus also 2—3 plates without primary tubercle may follow each other, sometimes also a couple of plates with primary tubercle. The secondary tubercles on the plates wanting primary tubercle are placed rather irregularly, the most common arrangement, however, being that a larger tubercle is found near the median edge of the plate, and a small one outside of the primary series, quite at the pores. On the uppermost ambulacral plates are found no secondary tubercles at all. — According to Bell (Catalogue. p. 153) the irregularity may be further increased by absorption of some of the tubercles. That an absorption of tubercles (and spines) once formed, may take place, I must doubt; it is, at all events, not the reason why primary tubercles are here wanting on every other (or still more) ambulacral plates, the fact being that they have never been formed on these plates. — The miliary tubercles are very little conspicuous, being of the same deep red colour as the test, while the other tubercles just are so conspicuous on account of their white colour.

The close-set spines are short and thick, rarely longer than 14—15^{mm}; in small specimens the spines are comparatively longer than in the large ones, scarcely, however, in any instance more than half the length of the diameter of the test. The spines on the actinal side are generally somewhat flat, but not widened at the point; the end is most frequently somewhat blunt, worn, I suppose, by the walk. Under higher magnifying powers the surface of the spines is seen to have a peculiar appearance, being finely, irregularly striped longitudinally on the ribs (Pl. XX. Fig. 30); this holds otherwise also good with regard to the other *Echinus*-species, as well as *Strongylocentrotus* and

Parechinus, although it is not equally marked in all of them. On the buccal plates and on a few of the other plates in the buccal membrane some small, club-shaped spines of a length of a couple of mm. are found (Pl. XX. Fig. 24). As these spines are found in no other genuine *Echinus*-species [1]), they are an excellent distinguishing character of this species; they are, however, not found in quite small individuals, until these have reached a diameter of ca. 15mm.

The buccal membrane contains numerous, more or less complicate fenestrated plates (Pl. XVI. Fig. 12); in larger specimens some of these are so large and thick, that they are seen as small knobs on the dried buccal membrane. Inside of the buccal plates they are more numerous and smaller, and are arranged in radiate series. A few bihamate spicules are rarely seen in the buccal membrane. In the gills they are found in larger numbers together with the common irregular fenestrated plates.

The pedicellariæ. The globiferous pedicellariæ (Pl. XIX. Fig. 24) with 1—1, sometimes 1—2 lateral teeth, otherwise without marked peculiarities. The tridentate pedicellariæ (Pl. XVIII. Figs. 13, 20) have a long, narrow, rather deep blade; from the upper end of the apophysis some mesh-work reaches a longer or shorter way into the blade; in small pedicellariæ no such mesh-work is found (Fig. 13). Only at the point, where the valves join, the edge is somewhat serrate; in the other part it is straight, but set with small teeth placed in transverse series as in the other *Echinus*-species. The ophicephalous and triphyllous pedicellariæ of the common form; sometimes, however, may be found a few large, elongate ophicephalous pedicellariæ, quite as those described above in *Ech. Alexandri*. The sphæridiæ (Pl. XIX. Figs. 28, 30) with few grooves, sometimes a little thorny. Spicules (Pl. XVIII. Fig. 12) of the common form.

By the »Ingolf»-Expedition this species has been taken on the following stations:

St. 6	(63° 43′ N. L.	14° 34′ W. L.	90 fms.	Bottom temp.	7° 5).	2	specimens.
— 54	(63° 08′ —	15° 40′ —	691 —	—	4° 2).	2	—
— 86	(65° 04′ —	23° 48′ —	76 —	—	?).	1	—
— 89	(64° 45′ —	27° 20′ —	310 —	—	8° 0).	1	—

Otherwise it is found along the European coasts from Britany to Spitzbergen and Iceland. Hoyle (op. cit.) mentions it also from the coasts of Spain and Portugal and from the Mediterranean, and Bell (Catalogue) further notes it from Port Natal and Brazil. The two last statements I must suppose to be incorrect, whether they are owing to wrong determinations or wrong labelling. A so wide distribution of a littoral species would be something quite exceptional, and if this large, conspicuous species were really found on the coasts of South Africa and Brazil, we should certainly have sufficient statements of this fact. I must also regard its occurrence in the Mediterranean as doubtful, probably owing to a confounding with other species (*acutus*?). When Hoyle cites Carus as an authority for its being found in the Mediterranean, it must be owing to a misapprehension. Carus, in his »Prodromus Faunæ mediterraneæ», does not mention this species, but only *Ech. esculentus* Lamk. (not L.) as a synonym of *Sphærech. granularis*. Sluiter (371) also mentions a specimen of *Ech. esculentus* L. from the Mediterranean, but I cannot regard this museum-statement as quite reliable either.

[1]) In the description of *Ech. lucidus* by Döderlein (114) it is said: Das Buccalfeld ist glatt bis auf 10 mässig grosse Plättchen, deren jedes einen grösseren Tuberkel und einige Pedicellarien trägt. This might indicate that also in this species spines may be found on the buccal plates. On the specimen I have examined, I have not, however, seen any such spines.

The greatest depth hitherto given for *Ech. esculentus* is 110 fathoms. Now it has been taken by the Ingolf on 310 and 691 fathoms. Certainly, however, it is not common on so great depths; it properly belongs to the littoral zone.

This species is not very varying. A peculiar form with especially fine spines and high test is by Norman [1]) denoted as var. *tenuispina*; it seems only to occur on greater depths. Hoyle further establishes a couple of varieties: *α.* with red test and spines, and *β.* with brownish-red spines (op. cit. p. 412), there is, however, I suppose, only slight reason to distinguish that kind of colour-varieties. A couple of specimens of a middle size from the North Sea (40 fathoms) found in the collection of our museum, have a very peculiar appearance, being very similar to *Ech. elegans*. The spines are uncommonly long and quite red, and the test not so high as usual. But the spines on the buccal plates and the fact that only every other ambulacral plate has a primary tubercle, leave no doubt of their being *esculentus*. These specimens perhaps correspond to Hoyle's var. *α.* A couple of larger, naked tests from Norway, also found in the museum of Copenhagen, combine to a curious degree the characters of both *E. esculentus* and *acutus*, var. *Flemingii*, so that it is quite impossible to decide with certainty to which of these species they belong, and the supposition of their being hybrids between the two species seems very obvious.

It seems that the species *Ech. Schwartzii* described by Nilsson & Holst, can be no other thing than a young *E. esculentus*; there is nothing in the description that will not agree with this species, and other Echinids with red test are not found at the Norwegian coast on the rocks at the very edge of the water; otherwise the type specimen is no longer found in the museum of Lund.

Fam. **Toxopneustidæ.**

Subfam. **Strongylocentrotinæ.**

17. **Strongylocentrotus drobachiensis** (O. F. Müll.).

Pl. I. Figs. 5–6. Pl. II. Figs. 3–5. Pl. XVI. Figs. 4, 9, 11, 13, 17, 21, 23. Pl. XX. Figs. 3–6, 12–13, 16, 18, 20, 25–26, 29.

Principal synonyms: *Echinus neglectus* Lamk.
— *granularis* Say.
— *granulatus* Gould.
Toxopneustes pictus Norman.
— *pallidus* G. O. Sars.

Principal literature: Düben & Koren: Öfvers. Skand. Ech. p. 277. — Lütken: Oversigt over Grønlands Echinodermata. 1857. p. 24. — G. O. Sars: Nye Ech. fra den norske Kyst. Forh. Vidensk. Selsk. Christiania 1871. p. 25. — Agassiz: Revision of Echini. p. 277. — Duncan & Sladen: Mem. Ech. Artic Sea (135). p. 19. — Hoyle: Revised List of Brit. Echinoidea (202). p. 408. — Bell: Catalogue of Brit. Echinoderms. p. 156.

[1]) On the Crustacea, Tunicata, Polyzoa, Echinodermata, Actinozoa, Hydrozoa and Porifera. Shetland Final Dredging Report. II. Rep. Brit. Assoc. 1868. p. 314.

With regard to the other synonyms and the immense number of places in the literature where this species is mentioned or more thoroughly treated, the reader is referred to Rev. of Ech. and Bell's Catalogue. — As it has been treated so many times, I shall only here mention a few features that have not before been described with sufficient clearness.

With regard to the provision of the test with tubercles very great variation is found. On Pl. XVI. Figs. 17 and 23 is represented an ambulacral and an interambulacral area of a specimen with comparatively few tubercles (Sars's *Str. pallidus*), Figs. 11 and 21 represent the same of a specimen with numerous tubercles (*granularis* Say). The difference is here very conspicuous, and nevertheless the represented forms are by no means extreme ones. All transitional forms between these may be found. The number of the pores varies between 4—7, but most commonly 5 or 6 are found. Generally two ocular plates reach to the periproct (Pl. XVI. Fig. 9), sometimes three, more rarely one. On Pl. XVI. Fig. 4 is figured the apical area of a specimen with two pores in one of the genital plates.

The buccal membrane contains rather numerous fenestrated plates some of which are large, very complicated, and carry pedicellariæ; those inside of the buccal plates are, as usual, smaller (Pl. XVI. Fig. 13). Very few bihamate spicules in the buccal membrane and the gills, which latter otherwise contain the usual irregular fenestrated plates.

The pedicellariæ. It was the pedicellariæ of this species which were figured by O. F. Müller in Zoologia danica; among the later authors only Perrier[1]) has studied them more thoroughly and figured some of the skeletal parts. Also Agassiz gives some figures (Rev. of Ech. Pl. X), but they are too small to show the interesting features found here. — The globiferous pedicellariæ (Pl. XX. Figs. 16, 25, 26, and 29) are highly characteristic and widely different from those of all the other Echinids occurring in the northern Atlantic. The head is not, as in those, placed directly on the stalk, but connected with it by a long, muscular neck, provided with as well longitudinal as circular muscles, so that it may be stretched out and retracted, and the head may be moved freely in all directions. The blade is tubular, without lateral teeth, only with a more or less marked obliquity above. Perrier's figure (Pl. V. Fig. 7. a) of such a valve is rather unfortunate, as it seems to show two end-teeth. The form of the basal part is rather varying, as the outer corners may be more or less conspicuous or bent somewhat inward. Most frequently some spicules are found in the head, arranged in a narrow band along the edge of the valves (Fig. 29). The stalk is a hollow tube peculiarly furrowed above. (Also the stalks of the other pedicellariæ are hollow.) The globiferous pedicellariæ are generally large and strong; they are sometimes found in so great numbers as to be almost more conspicuous than the spines (on the abactinal side). Sometimes they are quite light, sometimes quite dark from pigment; the more pigmented they are, the fewer spicules they seem to contain; they may also quite want spicules.

The tridentate pedicellariæ are of very different forms (Pl. XX. Figs. 4, 6, 20); the blade may be long and narrow, or short and broad, deep with almost adjoining edges, or flat and broad; now there is a strong mesh-work, now almost none. The ophicephalous and triphyllous pedicellariæ (Pl. XX. Figs. 3, 5) without marked peculiarities. — The spicules (Pl. XX. Fig. 12) are branched at the ends, but

[1]) Recherches sur les Pedicellaires. p. 152.

also really bihamate spicules are found, although only in small numbers. The sphæridiæ (Pl. XX. Figs. 13, 18) quite smooth or a little thorny, sometimes also a little grooved.

By the Ingolf-Expedition it has been taken on the following stations:

St.	2	(63° 04′	N. L.	9° 22′	W. L.	262	fms.	Clay, gravel.	Bottom temp.	5°	9).	2	spec.
—	4	(64° 07′	—	11° 12′	—	237	—	Stones.	—	3°	).	2	—
—	6	(63° 43′	—	14° 34′	—	90	—	Sand.	—	7°	5).	2	—
—	15	(66° 18′	—	25° 59′	—	330	—	?	—	÷ 0°	35).	3	—
—	16	(65° 28′	—	27° 05′	—	250	—	?	—	6°	4).	1	—
—	29	(65° 34′	—	54° 31′	—	68	—	Sand.	—	0°	5).	8	—
—	31	(66° 43′	—	55° 57′	—	88	—	?	—	2°	0).	6	—
—	32	(66° 35′	—	56° 38′	—	318	—	Mud.	—	4°	2).	1	—
—	33	(67° 57′	—	55° 30′	—	35	—	Coarse sand.	—	1°	4).	1	—
—	34	(65° 17′	—	54° 17′	—	55	—	Sand.	—	0°	9).	5	—
—	52	(63° 57′	—	13° 32′	—	420	—	?	—	7°	2).	1	—
—	86	(65° 04′	—	23° 48′	—	76	—	?	—	?	).	1	—
—	87	(65° 02′	—	23° 58′	—	110	—	?	—	?	).	46	—
—	98	(65° 37′	—	26° 27′	—	138	—	?	—	6°	2).	3	—
—	115	(70° 50′	—	8° 29′	—	86	—	Mud.	—	0°	4).	1	—
—	127	(66° 33′	—	20° 05′	—	44	—	Sand.	—	5°	9).	34	—

It is very widely distributed being found in all the arctic seas, and passing far to the south, both in the Atlantic (to the English Channel and Massachusetts Bay) and in the Pacific (to Vancouver Island and Korea). It is a littoral form, but goes rather deep; by the «Ingolf» it has been taken on a depth of 420 fathoms, and Verrill even mentions it from 640 fathoms (426. p. 540.)

It is no wonder that a so widely distributed species is very varying; a whole series of «species» has also been established on more or less marked forms of it. I completely agree with Agassiz, Bell, a. o. that it is quite impossible to keep the forms described under the name of *pallidus*, *granularis*, *pictus*, and *carnosus*[1]) distinct from the typical *drobachiensis* or from each other. Forms are not rarely found, to be sure, which may easily be referred to these forms, but most frequently such a referring will be impossible. I have examined several hundreds of specimens and found all possible transitional forms. Marked local forms seem not to be found; but as a general thing it may be said that in the Danish seas a more long-spined form is the most common one, at the Faroe Islands a form with numerous short, strong spines and almost without spicules in the globiferous pedicellariæ seems to be predominant (most nearly the form *granularis*); the Icelandic and East-Greenland specimens seem upon the whole to have very numerous spicules in the globiferous pedicellariæ, and the Pacific specimens may often be referred to the form *carnosus*; quite typical *drobachiensis* are, however, found so far down as Korea (after specimens in the museum of Copenhagen). These forms may so far be kept up as distinct varieties, but I do not see that we gain anything by it. Most specimens it will certainly be impossible to refer to any decided one of these varieties, and the separate varieties may often be found together. Neither can any difference be pointed out between the forms from shallow water and those from deep water.

Also the colour is very varying; most common is a grayish white or a somewhat greenish colour,

[1]) With regard to *Str. chlorocentrotus* see above p. 120.

but frequent are the reddish or dark, almost black specimens; a fine violet specimen may now and then be found (Pl. I. Figs. 5—6. Pl. II. Figs. 3—5).

Rodger (333. p. 163) speaks of an «extraordinary variety of *Str. drobachiensis*, with enormous pedicellariæ». It must decidedly be asserted that a variety cannot be established characterized by especially large pedicellariæ; the size of the globiferous pedicellariæ (and they are certainly meant) is so very varying, that it would be a quite absurd thing to distinguish different forms by this feature; the difference in size is, moreover, increased by the neck of the pedicellariæ being now stretched out, now retracted. We might with more probability expect to find a difference of importance in the tridentate pedicellariæ, but the different varieties cannot be distinguished by means of those either. A «Var. with slender, reddish spines», mentioned by Verrill (416. p. 504), is scarcely better characterized than the other varieties.

There are in the literature a few statements of other regular Echinids from the North-European seas. Agassiz (10) enumerates *Echinus melo* among Echinids from the Faroe-Channel, but adds: «there is nothing new». Here must, I think, be some mistake, and I must quite agree with Bell (Catal. p. 155) that *Ech. melo* cannot on this basis be included in the fauna of the North-European seas — quite apart from the question, whether *Ech. melo* can upon the whole be kept up as a distinct species.

Dalla Torre (108. p. 92) mentions «*Strongylocentrotus*» *lividus* from Helgoland; this is, no doubt, a confounding with *Str. drobachiensis*, which latter is not named. Further Herdmann (194. p. 89) mentions «*Str.*» *lividus* from Norway without further informations; this is surely also a mistake. The Norwegian coast-fauna has been so excellently examined by so many eminent Norwegian naturalists, that it is quite inconceivable that this large, fine Echinid should have been overlooked. Finally Sluiter (371. p. 70) states to have a specimen of *Sphærechinus granularis* from Denmark. Unfortunately we must relinquish our claim to the joy of having this beautiful and interesting Echinid in our seas; the northernmost locality, from which it is known, is the Channel Isles. (Bell. Catalogue. p. 106).

Table of the Echinids of the Families Echinidæ and Toxopneustidæ[1]) occurring in the northern Atlantic and the Mediterranean.

1.	The spicules simply bihamate, the globiferous pedicellariæ with 1—more lateral teeth on either side.....	2.
	The spicules branched at the ends or dumb-bell-shaped, the globiferous pedicellariæ without lateral teeth.....	13.
2.	The pores trigeminate.....	3.
	— multigeminate.....	*Paracentrotus lividus* (Lamk.).
3.	The globiferous pedicellariæ with the edges of the blade fine, projecting into several large indentations on either side; no cross-beams connect the edges across the inside..	4.

[1]) In this table the species *Echinus gracilis*, *atlanticus*, and *lucidus* have been included, so that it comprises all sure *Echinus*-species.

The globiferous pedicellariæ with the edges of the blade thickened, connected by cross-beams across the inside (in *Ech. Alexandri*, however, sometimes without such cross-beams) ..... 5.

4. The plates on the buccal membrane thick, greenish, of a peculiar structure (a compact calcareous mass with deep, funnel-shaped holes); they form a dense covering..... *Parechinus microtuberculatus* (Blv.).

The plates on the buccal membrane not greenish, of the common structure; they form no quite dense covering, naked skin is seen between them..... *Parechinus miliaris* (Müll.).

5. Primary tubercle on all the ambulacral plates..... 6.

— — only on every other ambulacral plate... 11.

6. The tridentate pedicellariæ with the blade broad and rather flat; the globiferous pedicellariæ generally with 3—4 teeth on either side of the blade..... *Echinus Alexandri* Dan. Kor.

The tridentate pedicellariæ with the blade narrow and deep; the globiferous pedicellariæ with 1—2 teeth on either side of the blade..... 7.

7. The primary tubercles on the ambulacral areas of very unequal size, or, if the size decreases regularly towards the apical area and the peristome, the two series in each ambulacral area of very different size..... *Echinus affinis* Mrtsn.

The primary tubercles on the ambulacral areas decrease regularly in size towards the apical area and the peristome; both series of equal size..... 8.

8. The test high..... 9.

— rather flat..... 10.

9. Finely red; the ophicephalous pedicellariæ with uncommonly long blade..... *Echinus atlanticus* Mrtsn.

With a fine green coloration; the ophicephalous pedicellariæ of the common form..... *Echinus gracilis* Ag.

10. The globiferous pedicellariæ generally with 2—2 lateral teeth; the test and the spines generally finely red and white, more rarely the test violet..... *Echinus elegans* Düb. Kor.

The globiferous pedicellariæ generally with 1—1 lateral tooth; the test and the spines white..... *Echinus lucidus* Döderl.

11. Spines on the buccal plates; the primary spines short, thick, not distinctly longer than the secondary ones..... *Echinus esculentus* L.

No spines on the buccal plates; the primary spines considerably longer than the secondary ones..... 12.

12. Only every other interambulacral plate above the ambitus with a primary tubercle: the primary spines rather short, greenish; the form of the test almost globular..... *Echinus melo* Lamk.

Only a few interambulacral plates nearest to the apical area want primary tubercle; the primary spines most frequently rather long, reddish; the test high or more or less flat *Echinus acutus*[1]) Lamk.

13. The spicules branched in the ends, none dumb-bell-shaped; the globiferous pedicellariæ with long, muscular neck; no glands on the stalk. The pores multigeminate..... *Strongylocentrotus drobachiensis* (Müll.)

The spicules of the pedicellariæ dumb-bell-shaped, those of the tube feet branched in the ends; the globiferous pedicellariæ without neck, with glands on the stalk. The pores multigeminate..... *Sphærechinus granularis*[2]) (Lamk.).

Several results of importance to the study of the geographical distribution will appear from the present researches. A complete representation of these results must, however, be delayed, till the irregular Echinids have been treated. Here I shall only briefly mention one feature of greater interest, viz. the resemblance between the arctic-subarctic and the antarctic-subantarctic Echinid-fauna, as this resemblance is chiefly based on the regular Echinids.

Meissner (285) gives a comparison of the Echinid-fauna of the two regions after the statements in the literature: one species occurs in both these regions, is bipolar, viz. *Echinus norvegicus*. The following species represent each other: *Cidaris canaliculata* and *papillata*, *Echinus magellanicus* and *miliaris*, *E. margaritaceus* and *elegans*, *Strongylocentrotus albus* and *drobachiensis*, *Schizaster Philippii* and *fragilis*. I shall express no opinion with regard to the two *Schizaster*-species, but all the other points of resemblance between the two faunas are quite illusory. I have shown above that *Echinus norvegicus* is not bipolar. The statement originates from Agassiz (Challenger Echinoidea p. 117), but is wrong. The specimens (from st. 308) that have been referred to *Ech. norvegicus*, are partly *Sterechinus magellanicus*, partly an *Echinus*-species that has nothing to do with *norvegicus*; it belongs to the species with primary tubercle on all the ambulacral plates; it is perhaps a new species. — *Cidaris canaliculata* and *papillata* can in no way be said to correspond to each other, they belong to two different genera, *Stereocidaris* and *Porocidaris*; any two other Cidarids might as justly be said to represent each other. *Echinus magellanicus* and *miliaris*, to be sure, are rather similar with regard to habitus, but as they belong, not only to two different genera, but to two different sub-

[1]) With regard to var. *mediterranea*, *Flemingii*, and *norvegicus* I must refer to the description above (pp. 154—155).

[2]) I cannot give the characters of *Sphærechinus roseus* more particularly, as I have not seen this species; the reader is referred to Russo's description of it (347).

families, they cannot be said to correspond very exactly to each other. *Echinus margaritaceus* and *elegans* must be referred to two different genera, *Strerechinus* and *Echinus*, so that these species can not be placed as substitutes for each other either. Upon the whole it is worthy of notice that it proves necessary to refer all the antarctic «*Echinus*»-species to another genus (*Sterechinus*) than the northern species. It seems to be rather gratuitous to place the separate species of these two genera against each other as substitutes. With regard finally to *Strongyloccutrotus drobachiensis* and *albus*, they, to be sure, have some resemblance as to habitus — nevertheless they belong to two different families. — With this I suppose it to be sufficiently proved that there is no special resemblance between the arctic-subarctic and the antarctic-subantarctic Echinid-fauna.

APPENDIX.

By an assistance received from the Carlsberg Fond, for which I here render my best thanks, I was enabled to go abroad for a longer time during the summer of 1902 to visit several of the most important museums, especially British Museum and the Museum of Paris. By this I have been enabled to decide many of the questions which in the preceding work I had been obliged to leave undecided. As the printing of the work had already gone so far, that nothing could be corrected or added, these informations are here given in an appendix. Neither was it possible to insert any reference to the appendix in the places concerned of the text.

I beg leave to offer my best thanks to Messrs. Prof. Pfeffer, Sluiter, Bell, Perrier, de Loriol, Döderlein, and Möbius, as well as to Dr. Meissner for the liberality they have shown especially by giving me free admission to examine the type specimens, which are of so very great importance.

The treatment of the pedicellariæ (pp. 10, 55). For the isolation of the skeletal parts it is more convenient to use hypochlorite of sodium (Na OCl.) (Eau de Javelle); it acts very quickly, and has not to be heated as the solution of potash. Especially by the treating of very small forms of pedicellariæ hypochlorite of sodium is absolutely to be preferred, as the skeletal parts are by this means easily isolated on the objectglass. Prof. Döderlein has drawn my attention to this very practical manner of proceeding.

»*Globiferæ*» Hamann (pp. 10, 55). As I had had no occasion to examine these organs myself, I supposed them really to be globiferous pedicellariæ, whose peculiar appearance was due to the highly developed glands on the stalk and the reduction of the head. In his preliminary report of the Echinids of the Siboga-Expedition[1]), de Meijere has given the information that they are really ophicephalous pedicellariæ. Having now had the occasion to examine these peculiar pedicellariæ myself I must corroborate the correctness of the statement of de Meijere; in *Centrostephanus longispinus*, to be sure, they are somewhat different from the ophicephalous pedicellariæ where glands are wanting on the stalk, but in *Aspidodiadema* they are constructed in quite the same manner as these. Accordingly it is absolutely inadmissible to use the name of Globiferæ of these pedicellariæ, they are morphologically highly different from the globiferous pedicellariæ. If a special name is needed for them, they must be called »claviform» pedicellariæ, which name has been proposed by Foettinger (155) what

[1]) Vorläufige Beschreibung der neuen, durch die Siboga-Expedition gesammelten Echiniden. Tijdschr. d. Nederl. Dierk. Vereen. (2) VIII. 1902. p. 16.

Hamann has overlooked, though he repeatedly quotes the paper by Foettinger. The name of «Globiferæ» must then be rejected for these pedicellariæ in the *Diadematidæ* on account of priority as well as morphology. In *Sphærechinus* the case is quite different; here they are evidently (rudimentary) globiferous pedicellariæ; the name of «claviform» pedicellariæ cannot be applied to them.

Dorocidaris papillata. The arrangement of the tubercles in the ambulacral areas described p. 32 (Pl. IV. Fig. 8) is no constant feature. In some specimens from the Shetland Islands brought home by Cand. mag. A. S. Jensen, the secondary tubercles are sometimes placed opposite to those in the primary series, sometimes alternating with these (as in *Cidaris affinis*), sometimes there is a tubercle both opposite to the primary one and one down in the inner corner of the ambulacral plate.

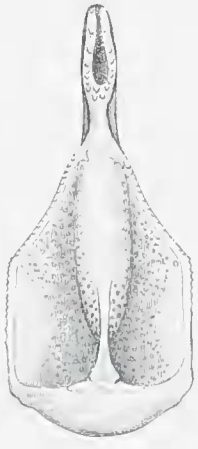

Fig. 7.

Fig. 8.

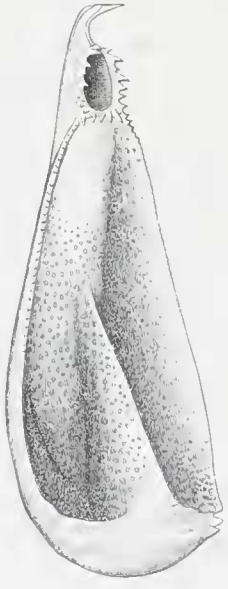

Fig. 9.

Fig. 7. Valve of a large globiferous pedicellaria of *Stereocidaris Lorioli.* Obj. AA. Oc. III. (Zeiss).
— 8. — - small — — - *Stereocidaris Lorioli.* Obj. AA. Oc. III. (Zeiss).
— 9. — - large — — - *Dorocidaris nuda.* Obj. AA. Oc. III. (Zeiss).

With regard to the hitherto uncontrolled statements of the occurrence of *D. papillata* (p. 35) I am now able to give the following informations: the specimen from St. Pauls Rock (Challenger) is a *D. papillata.* This locality is the southernmost one, from which the species is known, — the specimens (2) from the still more southern locality, «Challenger» st. 320 (off the mouth of the River Plate) being no *D. papillata*, but a species hitherto not described. The spines resemble those of *D. papillata*, have a slightly reddish, rather long neck; there are about 18 longitudinal ribs, serrate as in *C. affinis*; between the ribs slightly branched «hairs» are found, so that a transverse section of the spines gives a quite similar figure as in *D. papillata.* In the smaller specimen the spines are a little more thorny. No ampullæ on the secondary spines. The large globiferous pedicellariæ (Fig. 7) without end tooth, the blade a little prolonged. The mouth is long and narrow, surrounded by rather strong teeth. They are rather varying in size, the figured one is among the smaller. In the larger ones the lateral

corners are less conspicuous or even not indicated at all. The mouth may also be somewhat shorter, so that the whole valve reminds of the form peculiar of the genus *Cidaris*. The small globiferous pedicellariæ (Fig. 8) are of a quite different form, flat and broad, the lower limit little conspicuous; they are also very varying in size, and the larger specimens are very similar to tridentate pedicellariæ. Real tridentate pedicellariæ I have not found. The spicules of the common form. This species, no doubt, is to be referred to the genus *Stereocidaris*; I propose the name of **St. Lorioli** n. sp.

The specimens from Chall. st. 24 (Culebra Island) and from Gomera (The Canary Islands) I have not seen — they are not found in British Museum — and so I can give no informations of them.

Of the specimen of *D. papillata* mentioned by Studer (386), from 4° 40′ N. L. 9° 10′ E. L., 59 fathoms (the »Gazelle»-Expedition) (the mentioned locality is not, as Studer says, the Cape Verd Islands, but quite innermost in the Gulf of Guinea) I have (pp. 35, 37) expressed the supposition that it might be *Cidaris affinis*. This is not correct; it is a new *Dorocidaris*-species, very different from *D. papillata* as to habitus. The secondary spines are rather few, and, with the exception of the primary series in the ambulacral areas and a single circle round each radiole, very small, by which fact the whole test, but specially the apical area, gets a strikingly naked appearance. In the ambulacral areas a double series of spines is found in the median line, so small, that they do not reach to the base of those in the primary series. No »ampullæ» seem to be found. The secondary spines are reddish brown; according to Studer they are purple (on living individuals?); the colour of the test white. The radioles are likewise reddish brown, but of a lighter shade than the secondary spines; they are about $1^1/_2$—2 times as long as the diameter of the test, only a little tapering towards the point, ending in a little widening. There are ca. 9—11 more or less coarsely serrate, rather conspicuous longitudinal ridges; the »hairs» on the outer layer between the longitudinal ridges as in *D. papillata*, so that a transverse section of the spines gives the same picture as in the latter species. The actinal radioles not much serrate in the edge, upon the whole only little different from the others, excepting with regard to the length. The areoles comparatively very large, but not especially deep; they occupy almost the whole space, so that there is only room left for a few secondary spines outside of the single circle nearest to the radiole. No naked median line in the interambulacral areas or between the plates; no transverse furrows in the edge of the interambulacral areas as in *papillata*. The inner tubercles in the ambulacral areas are placed opposite to or a little below those in the primary series. — The mouth of the large globiferous pedicellariæ (Fig. 9) is regularly limited below, often by a straight line; it is surrounded by rather strong teeth. The dorsal side of the blade is less highly perforated than in *D. papillata*; the small globiferous pedicellariæ as in this species. The tridentate pedicellariæ are not so irregularly serrate in the edge and upon the whole less complicate in the lower part of the blade than in *D. papillata*. The spicules as in *papillata* and arranged as in this species. — This species, for which I propose the name of **Dorocidaris nuda** n. sp., I have also found in the museum of Paris, from »Talisman», st. 109, 70 m., and st. 110, 450 m., near Cape Verd, called *Dorocid. hystrix*, by which name it has been mentioned by Bernard (78).

It is still to be noted that the specimen of *D. papillata* mentioned in Rev. of Ech. p. 105, from Guadeloupe (Duchassaing), does not belong to this species; it is a *Cidaris* sp., probably *C. affinis*.

Thus I have established the fact that no less than 8 different species, of which, moreover, only

one belongs to the genus *Dorocidaris*, have in the literature been wrongly referred to *D. papillata*, viz. *Dorocidaris nuda*, *Tretocidaris annulata*, *spinosa*, *Cidaris affinis*, *baculosa* and another *Cidaris*-species (Chall. st. 204), *Stereocidaris Lorioli*, and another *Stereocidaris*-species (Chall. st. 210) — a fine demonstration of the trustworthiness of the statements hitherto found in the literature with regard to the occurrence and distribution of these animals.

Cidaris Thouarsii. The type specimen has a short limb on the stalk of the pedicellariæ; I suppose then, that the specimens, in which I have found a long limb (p. 17), do not belong to this species. The main point, however, is that *C. Thouarsii* as well as its close relation *C. Galapagensis*, belong to the genus *Cidaris*. I shall not here trench on the question whether *galapagensis* can really be kept up as a separate species.

Cidaris annulifera (pp. 19—20, 28). Having examined the type specimen of Lamarck in the museum of Paris I am able definitively to decide the question of this species. It is the species figured by de Loriol (243) under this name, and it is doubtless synonymous with *C. baculosa*, while it has nothing to do with *C. bispinosa* and the genus *Stephanocidaris*. The representation of these species given by Döderlein in «Bericht über die von Herrn Prof. Semon bei Amboina und Thursday Island gesammelten Echinoidea» (Semon. Zool. Forschungsreisen in Australien und dem Malayischen Archipel. V. 1902. — Jen. Denkschr. VIII[1]) is completely correct. The type specimen of *C. annulifera* is a naked test filled with wax, on which the radioles are fixed with needles. Secondary spines, pedicellariæ, and tube feet are completely wanting, but the red spots on the neck of the radioles leave no doubt that it is a form of *C. baculosa*. As *baculosa* is named first by Lamarck, the name of *annulifera* must be rejected as a specific name, can only be kept as the name of a variety of *baculosa*, as has been done by Döderlein. — On the other hand I cannot agree with Döderlein, when he adopts the name of *pistillaris* Lamk. instead of *baculosa*, because Lamarck names *pistillaris* as the first name. It would, no doubt, be correct if we could prove with certainty that *C. pistillaris* and *baculosa* are one species, but this we cannot do, as the type specimen seems to be existing no more. It is not found in the museum in «Jardin des plantes», and it cannot be decided, whether a specimen found under this name in «École des mines» in Paris, is a type specimen. It is to be noted, however, that this specimen has the red spots on the neck of the spines. Lamarck does not name «École des mines» under this species, neither is it in «Catalogue raisonné» mentioned from this collection. Two specimens from the Seychelles (Rousseau 1841) found in the museum in «Jardin des plantes» under the name of *pistillaris* do exactly want the red spots on the neck of the spines, but have close, bluish red streaks. Probably they are genuine *Cidaris*, perhaps only a variety of *baculosa*, but as I could find no large globiferous pedicellariæ on the specimens, I cannot decide it with certainty. Döderlein (op. cit. p. 693) says that «selten fliessen die Tüpfel in Längsstreifen zusammen»; I cannot see, however, that he has proved the specimens with these longitudinal streaks to be the same species as the typical *baculosa* — if individuals with both forms of spines might be found, it might be taken to be certain. — For the present I must regard this form with the longitudinal streaks (presumably the *C. pistillaris* of Lamarck) as a separate species or, at all events, a distinct variety of *C. baculosa* which is so very rich in forms.

[1]) This very important and excellent work did not appear till the printing of the present work was begun, so I have not been able to take it into consideration. It does not, however, overthrow any of my results.

To adopt the name of *pistillaris* in stead of *baculosa* I must, for the reasons given above, regard as unwarranted.

Schleinitzia crenularis (p. 20). — The specimen figured by Studer cannot be identified any longer with certainty in the museum of Berlin; a dried specimen without label resembles the figure rather much, but not quite — it is *C. baculosa* var. *annulifera*. Two other specimens in alcohol are *Stephanocid. bispinosa*, a form with little thorny spines as in var. *ramsayi* Döderl. (op. cit. p. 697). In the glass together with one of these specimens is found a loose spine of *C. baculosa* var. *annulifera*. No more specimens are found in the museum of Berlin. Thus *Schleinitzia crenularis* is = *Cidaris baculosa* var. *annulifera* and *Stephanoc. bispinosa*.

Acanthocidaris curvatispinis (p. 21). Of this species I found a specimen, also from Mauritius, in the museum of Paris, called *Dorocidaris?* The globiferous pedicellariæ are quite as in the type specimen; sometimes the two outmost teeth at the mouth may be united at the point and thus form an apparent end tooth. Tridentate pedicellariæ were not found on this specimen.

Histocidaris elegans (pp. 21—22). By a renewed examination of all the specimens in British Museum I have not been able to find any globiferous pedicellariæ; accordingly the valve figured on Pl. IX. Fig. 2, with two end-teeth is evidently an abnormity having nothing to do with this species. The genus *Histocidaris* then seems only to have tridentate pedicellariæ.

Stereocidaris nutrix (*Gonioc. membranipora* Studer) (p. 26). I have examined all the specimens of this species in the museum of Berlin; none of them have young ones on the periproct, but two have young ones round the mouth, quite as described by Wyv. Thomson. The remark by Studer quoted on p. 26 is thus incorrect, it must apply to his *G. vivipara*. No specimen of this species in the museum of Berlin carries any longer young ones, but some young are lying in a couple of small glasses together with them. Accordingly my interpretation of *Stereoc. nutrix* and *canaliculata* is no doubt correct.

Porocidaris purpurata. A couple of large, fine specimens in the museum of Paris (Talisman Riv. Ouro. 1439 m.) differ from the common form by the fact that in the uppermost (1—2) radioles of each series the neck is swollen in a fusiform manner and of a fine violet colour; the other spines are quite cylindric. Otherwise it agrees with *purpurata*, also the pedicellariæ are quite as in this species. I suppose it to be a separate species, but as I can give no other characters of it, I shall only designate it as a variety of *P. purpurata* under the name of var. **Talismani** n. var.

Dorocidaris tiara. Of this species I have examined a specimen from Calcutta in the collection of de Loriol. With regard to spines and pedicellariæ it agrees exactly with *Stephanoc. bracteata* (Ag.), and so it is evidently a synonym of this species.

Phormosoma placenta. After the printing of the section of the Echinothurids, a glass was found with some small young ones of this species from st. 25; the smallest ones have only a diameter of 3^{mm}, and are thus considerably smaller than the youngest stages of Echinothurids hitherto known[1]). Thus it will be of great interest to get information of these younger stages. Agassiz has, in «Blake»-Echini, given some informations of the development of *Phormosoma*, but as the youngest of

[1]) The specimen of «*Asthenosoma*» *hystrix* of $3{,}1^{mm}$, mentioned and figured in Rev. of Ech. p. 273 (Pl. II. c.) is scarcely an Echinothurid; at all events there is neither in the description nor in the figures anything showing it.

his specimens had a diameter of 8mm, he has not, of course, been able to give all the necessary informations. To this is to be added that I must decidedly contest the correctness of several of the most important statements of Agassiz.

The form of the test is in specimens of a diameter of 3mm as in a common *Echinus*, not flattened, and the plates are not yet imbricated; already in specimens of a diameter of 5mm the test is a little flattened. In the smallest specimens the peristome is quite covered by the 10 large buccal plates; only inside of these, nearest to the mouth, a few small, irregular plates are seen. All the 10 buccal tube feet are well developed and of equal size; spines are not yet found on the buccal plates. In a specimen of a diameter of 5mm there are 5 spines on the buccal plates, one for each pair of tube feet; here ambulacral plates have begun to appear on the buccal membrane outside of the buccal plates. A specimen of a diameter of 7mm has 10 spines on the buccal plates alternating regularly with the tube feet, so that spines and tube feet together form a regular circle; here also 5 spines have appeared outside of the first circle, one opposite to each ambulacrum. According to Agassiz the buccal plates in *Phormosoma placenta* should not differ in size from the other plates on the peristome, so that the Echinid features of the actinostome did not seem to occur in this species. This is incorrect; in the youngest stages the buccal plates are easily recognised by their size — but it is to be admitted that this difference in size soon disappears, the other plates of the peristome reaching about the same size. Of these plates in the peristome Agassiz (op. cit. p. 32) says that they »are developed ... independently of the coronal plates; new plates forming on the distal surface of the actinostome, which are intercalated between the old plates and the coronal plates». This is absolutely incorrect; the plates of the peristome are ambulacral plates displaced adorally (Lovén); on a contrary supposition beginnings of them and quite small plates must be found outermost in the peristome, but this is not the case — on the contrary the outermost plates are the largest. In »Challenger»-Echinoidea p. 73 Agassiz also says that these plates »are formed by becoming detached from the ambulacral zones».

In the smallest of the specimens in hand there are as yet only ca. 7 pairs of tube feet, besides the buccal ones. There is no distinct difference between the primary and the accessory ambulacral plates; only in a specimen of a diameter of 7mm the primary one begins to grow larger than the others, and it carries now 1—2 tubercles, while the small ones have at most a small miliary tubercle. In specimens of this size the areoles begin to be deepened, so that the difference between the actinal and abactinal side is now already indicated. — Auriculæ are already distinct in individuals of a diameter of 6mm, but are as yet only a pair of small processes, not connected above. The gills do not appear till later; in individuals of a diameter of 10mm they are not yet to be seen. A few triphyllous pedicellariæ, of the same form as in the adult, and a few sphæridiæ are already found in the smallest specimens. — The apical area is in all essentials as in the youngest stage figured (Pl. IV. Fig. 2). The periproct is, even in the smallest specimens, covered by a number of small, irregular plates, with no larger plate between. So a central plate seems never to be found here. The genital plates join for a long space, so that the ocular plates are widely separated from the periproct; these plates are much lengthened, reach down quite to the middle of the test, and here the pore is placed, which, in accordance with its morphological signification as the opening of the terminal feeler (the point of the

radiary canal), is found from the earliest stages, and not, as stated by Agassiz (op. cit. p. 35), only formed, when the animal has reached a size of 20mm.

Of the formation of the interambulacral plates the following very remarkable statement is found in Agassiz (op. cit. p. 32): »On the abactinal system ... while the plates of the genital ring are well defined and seem to be distinctly separated from the coronal plates, yet new interambulacral plates are not added independently as in the ambulacral system and in the interambulacral system of other young Echinids where the genital ring remains permanently closed. The new interambulacral plates are found to be pushing out from the plates of the anal system on each side of the genital plates. As the ocular and genital plates of the genital ring become separated with increasing size, the additional anal plates formed in the intervening spaces are pushed out, and become a part of the abactinal portion of the interambulacral area. ... This shows a far closer relationship between the young of some of the Sea-urchins of the present day with Starfishes and Ophiurans on the one side and Holothurians on the other, than had been suspected formerly». — This statement is completely incorrect. The interambulacral plates are formed in *Ph. placenta* as in other Echinids, not by the anal plates. The genital ring, at all events, is closed, until the animal has reached a size of 17mm in diameter, and so far accordingly the interambulacral plates must necessarily be formed in the common way, as may also easily be substantiated. In a specimen of a diameter of 30mm a couple of ocular and genital plates are still joining, and here the case is quite the same. That a new mode of formation of the interambulacral plates, otherwise quite unknown among the Echinids, should then suddenly occur, is very improbable — and, above all, Agassiz has not at all proved it; all that may be seen in the larger specimens, is that the small anal plates directly adjoin the uppermost interambulacral plates. Thus the more close relation between Asterids, Ophiurids, Holothurids, and »some of the Sea-urchins of the present day», which Agassiz derived from this feature, is quite illusory.

Calveria gracilis. — The parasitic Copepod from the spines of this species, mentioned on p. 51, has been described by Dr. H. J. Hansen in Vidensk. Medd. fra Naturh. Foren. Kobenhavn 1902 by the name of *Echinocheres globosus.*

Araeosoma fenestratum. In a well preserved specimen from Blake 1880 (with no more precise locality) found in the museum of Paris, I have found the tetradactylous pedicellariæ together with as well the large as the small form of tridentate pedicellariæ. If still some doubt might be left of the correctness of my interpretation of this species, no doubt will hereafter be possible.

Through Prof. Bell I have from Department in the course of fishing investigations received some specimens of an Echinothurid from west of Ireland (Porcupine Bank, 199 fathoms) which prove to be closely allied to *A. fenestratum*, but are, no doubt, nevertheless to be interpreted as a separate species. The structure of the test differs somewhat from that of *A. fenestratum.* In the latter the interambulacral plates are lower in the middle, and widened in both ends, in the former most of the plates are not widened at all in the outer end. (This character, however, is scarcely very reliable — comp. Bell (72)). The primary tubercles of the ambulacral areas form on the actinal side a rather regular longitudinal series out at the tube feet, in *fenestratum* they are arranged more irregularly. Otherwise no difference is found in the arrangement of the tubercles between this species and *fenestratum*, only, perhaps, the secondary spines are somewhat more numerous in the new species.

— Tetradactylous pedicellariæ I have not found. The tridentate and triphyllous pedicellariæ as in *fenestratum*; the large form of tridentate pedicellariæ is found in very different sizes, but also the small ones are of the typical structure, so that they cannot be confounded with the other form. Besides the forms of the second kind of tridentate pedicellariæ mentioned and figured for *fenestratum*, a form is also found here where the blade is not at all involved below (Fig. 10). I have, however, once found this form in *A. fenestratum* (in a specimen from Barbados, in British Museum), and so it can be no specific character. The spicules, perhaps, are a little smaller than in *fenestratum*, but this difference is too little marked to be used as a specific character. The best character is the colour, which in the preserved specimens is deeply dark violet, while all the specimens of *fenestratum* I have seen, are quite bleached in alcohol: also in the living animals the colour is quite different — comp. the description by Wyv. Thomson. The primary spines on the actinal side are dark with a rather large, white hoof, very conspicuous on the dark ground-colour. — The organs of Stewart are very large; the longitudinal muscles powerful. — For this species, the place of which is evidently between *A. fenestratum* and *coriaceum*, I propose the name of **Aræosoma violaceum** n. sp.

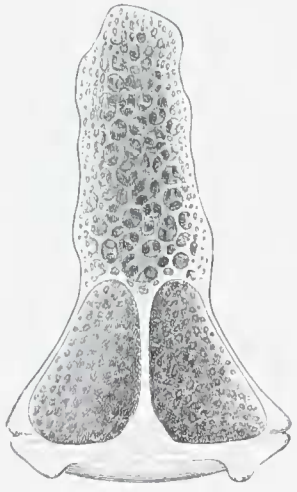

Fig. 10.

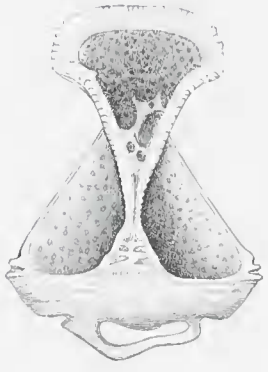

Fig. 11.

Fig. 10. Valve of tridentate pedicellaria of *Aræosoma violaceum*. Obj. AA. Oc. II. (Zeiss).

Fig. 11. Valve of ophicephalous pedicellaria of *Hygrosoma Petersii*. Obj. AA. Oc. I. (Zeiss).

Echinosoma uranus (p. 57). A couple of specimens of this species (Talisman Sahara, 938 m.) I have seen in the museum of Paris. All the primary spines on the actinal side were broken, but some of the spines round the mouth had a little hoof; after this there can be no doubt that the primary spines on the actinal side end in a hoof as in *E. tenue*. The large tridentate pedicellariæ are quite similar to the one of *E. tenue* figured on Pl. XII. Fig. 35, with the exception that here the apophysis does not continue into the blade as a crest.

Hygrosoma Petersii (p. 59). In a specimen of this species (the Azores, 1258 m. Talisman. The museum of Paris) was found a pedicellaria (Fig. 11) forming a transition between the ophicephalous pedicellariæ in *Tromikosoma Kochleri* and the short, thick pedicellariæ of *H. luculentum*. After this there can be no doubt that *luculentum* is really to be classed together with *H. Petersii*, and it may well be supposed that this form of pedicellariæ will also be found in *H. hoplacantha* — in other words that it is one of the characters of the genus *Hygrosoma*. Whether it is then to be regarded as an ophicephalous or a transformed tridentate pedicellaria is so far of no consequence; I think it, however, most correct to regard it as an ophicephalous one, although in *luculentum* it is not of the typical structure. — The form of pedicellariæ in *H. luculentum* (Chall. Pl. XLIV. Fig. 27) mentioned on p. 60, I have not been able to find by a renewed examination of the specimen from st. 200, although this specimen is rather well preserved. — If thus ophicephalous pedicellariæ are found in the genus

Hygrosoma, the difference between the latter and the genus *Tromikosoma* becomes rather more slight than stated in the diagnoses. Then there is only any difference of importance in the form of the tridentate pedicellariæ; but this difference is so great, that I, at all events for the present (until transitional forms become known), must regard the genus *Tromikosoma* as a legitimate one.

Kamptosoma asterias (p. 60). All the three specimens from Chall. st. 272 which Agassiz has determined as *Phormosoma tenue?*, are *K. asterias*. After a renewed examination I must regard it as unjustified to establish a separate species of this genus on them. — It is the primary spines on the actinal side that are flat and widened at the point (Pl. XIV. Fig. 29); below they are round, tubular, and then they become evenly flattened towards the point. They are a little curved; a hoof is scarcely found. The spines nearest to the mouth are surrounded by a rather thick bag of skin, not widened at the point. The small, accessory ambulacral plates are really wanting, only nearest to the peristome a single one may be found. For each ambulacral plate here are as usual three branches from the radial canals, but two of them are quite thin and their ampullæ rudimentary, and their tube feet are not developed at all.

Sperosoma Grimaldii (p. 75). Of this species I have found ca. 20 specimens in the museum of Paris (Talisman, the Azores, Morocco, 300—1257 m.), determined partly as *Phormosoma uranus*, partly as *Asthenosoma hystrix*. Our museum has further received some specimens of different sizes from the Faroe Channel (59° 29′ N. L. 7° 51′ W. L. 580—689 fathoms. Michael Sars. Ad. S. Jensen), a corroboration of the supposition with regard to its geographical distribution expressed above. — Rather great variation proves to be found in the mutual relation of the size of the abactinal ambulacral plates; accordingly there cannot be laid much stress on the deviations in this respect from the type specimen of Koehler described above, and there can be no doubt that the large specimen figured on Pl. IV. Fig. 3, is a real *Sp. Grimaldii*.

Prionechinus sagittiger (p. 84). As far as can be seen on the type specimen preserved in alcohol (st. 218), no grooves are found in the test; to be able to state this fact with certainty, it will, however, be necessary to examine a dried specimen.

Echinus lucidus (pp. 100, 105) has calcareous plates in the buccal membrane as the other genuine *Echinus*-species; they are simple fenestrated plates as in *Ech. Alexandri*. There are no spines on the buccal plates (p. 161, note).

Sterechinus margaritaceus (pp. 101—102). De Loriol has called my attention to the fact that the figures of *Ech. margaritaceus* given in "Voyage de la Frégate Venus". Zoophytes Pl. VI. 1, do not agree with Koehler's description of *St. antarcticus*, especially as all the ocular plates in *margaritaceus* are shut off from the periproct. Trusting to the interpretation by Agassiz of *Ech. margaritaceus* as the correct one, I had omitted to examine this question more closely. According to a kind information from Dr. Gravier the type specimen is no more found in Paris. But to judge by the figures in "Voyage de Venus" there can scarcely be any doubt that Agassiz's (and my) interpretation of *Ech. margaritaceus* is incorrect; besides the ocular plates being shut off from the periproct, it seems also to appear from these figures that there is a primary tubercle on all the ambulacral plates. But then I do not see how *St. magellanicus* is to be distinguished from *margaritaceus*, and it is an obvious supposition that they are really one species; if this be the case the name of *magellanicus* will only be a

synonym of *margaritaceus*. The species described above as *margaritaceus*, will, if *margaritaceus* and *magellanicus* really be identical, get the name of *Sterech. diadema* (Studer), in which species *Sterech. antarcticus* (Koehler) is to be included as a synonym. With regard to the geographical distribution it will, I suppose, be proved that *St. diadema* (*margaritaceus*?) only occurs in the seas round Kerguelen, *St. margaritaceus* (*magellanicus*) round Patagonia — analogous with *Stereocidaris nutrix* and *canaliculata*. The statements of *diadema* (under the name of *margaritaceus*) from Patagonia, I think will have to be referred to *horridus*, which is, as to habitus, very similar to this species[1]). It is still to be observed that *St. diadema* has a distinct genital papilla.

Sterechinus horridus (p. 102). There are no plates in the buccal membrane outside of the buccal plates, which carry spines. The actinal primary spines are not curved. The character pointed out in the diagnosis of the genus *Sterechinus* (p. 135), that the buccal membrane is almost or quite naked outside of the buccal plates, is thus correct.

Pseudechinus albocinctus (p. 104). One of the anal plates is somewhat larger than the others, and carries a larger tubercle. No spines on the buccal plates.

Parechinus microtuberculatus (p. 107). The type specimen of this species is the common Mediterranean form; the statement of Blainville that it has 6 pairs of pores in each arc, is thus incorrect.

Sphærechinus australiæ (p. 117). Has a primary tubercle on all the ambulacral plates. Otherwise the specimen examined by me, is so very similar to *Sph. granularis*, that I should not be surprised, if it proved to be this species (— and in this case it is surely not from Australia —); perhaps I have then not seen the real *Sph. australiæ* at all.

Strongylocentrotus intermedius and *chlorocentrotus* (pp. 120—121). What I have hitherto regarded as *Str. intermedius* is not this species, but *Str. pulcherrimus* (comp. my supposition expressed on p. 121 that *pulcherrimus*, *intermedius*, and *chlorocentrotus* (?) might be one species). The real *intermedius*, which I got to know from Prof. Döderlein, is as to habitus very similar to *drobachiensis*, also with regard to pedicellariæ and spicules, but is — according to Döderlein's (not published) examinations — distinguished from this by having a considerably larger number of plates in both areas, and a rather smaller apical area than specimens of *drobachiensis* of the same size. At all events the two species are very closely allied.

Strongylocentrotus gibbosus (p. 123). The examination of the pedicellariæ of one of the type specimens in Paris shows that this species is an Echinometrid, I suppose of the genus *Toxocidaris*, or perhaps a new genus. With the genus *Loxechinus* this species has nothing to do; the specimen (Chall. st. 304), by which I referred *gibbosus* to this genus, is thus wrongly determined (what I had a slight impression of — comp. the incongruity in the relation of the ocular plates mentioned loc. cit.). Besides the two type specimens (Expedition de la Bonite. M. Gaudichaud. 1837) two specimens are found in

[1]) When the remarks above were printed, I received from the museum in Jardin des Plantes a specimen called *Ech. margaritaceus* from Cape Horn, 1894 (Coll. Cotteau). As to habitus it resembles *diadema*, the secondary spines, however, being somewhat coarser. All the ocular plates are shut off from the periproct; distinct central plate, as in *diadema*. Primary tubercle on every other ambulacral plate — somewhat indistinct towards the apical area. Primary spines round the mouth curved at the point; a few spines on the buccal plates. The pedicellariæ as in *diadema*. — Thus this specimen agrees neither with *diadema*, *horridus*, nor *Neumayeri*; nevertheless it seems rather irrational to interpret it as a separate species. The supposition that *diadema*, *horridus*, and *Neumayeri* are all together only one very varying species, seems to me to be rather obvious. But to decide this question a great material will be necessary.

the museum of Paris called *Str. gibbosus* Val. (I. Galapagos. M. Rousseau. 1846). They are *Sphærechinus granularis* (or, if they be really from Galapagos, another *Sphærechinus*-species (*australiæ*?)). On the back of the label is written — acheté à Londres — thus the locality cannot be regarded as reliable.

Paracentrotus Gaimardi (p. 124). On a specimen of this species in the museum of Paris (the type specimen of *Ech. aciculatus* Hupé, which is a synonym of *Gaimardi*) I have found a small tridentate pedicellaria; it was somewhat broken, but showed nevertheless sufficiently that it is similar to those of *P. lividus*, so that a specific character is scarcely to be found in it.

Anthocidaris homalostoma (p. 125). The type specimens of *Ech. homalostoma* Val. are two naked tests that are really very similar to *Anthocidaris*; but it cannot be decided by the naked tests whether they are the same species. The locality (New Zealand) tells against the identity. I have above (loc. cit.) said that the name of *homalostoma* would have to be used whether they be identical or not. According to the opinion of Döderlein expressed to me, this is incorrect, and I shall readily submit to his authority. Then the species will get the name of *Anthocidaris crassispina* (Ag.).

Strongylocentrotus nudus (pp. 126, 140). A specimen of this species (from Hakodadi — Japan) I have examined in Strassburg. No globiferous pedicellariæ were found on it, but the spicules show it to be a genuine *Strongylocentrotus*. The tridentate pedicellariæ occur in three different forms, as in *drobachiensis*; a short, broad one ($1{\cdot}5^{mm}$) resembling that figured on Pl. XX. Fig. 20; a long, narrow one (2^{mm}) resembling that figured on Pl. XX. Fig. 6, only more serrate below; and finally a small one (ca. $0{\cdot}5^{mm}$), more particularly corresponding to the third form in *drobachiensis* (Pl. XX. Fig. 4); it is simply leaf-shaped with quite straight edge, without marked indentations. The other pedicellariæ show no peculiarities.

Strongylocentrotus mexicanus (pp. 126, 140). The specimens from Chili mentioned by Sluiter (371), are Echinometrids — but whether they be really *Str. mexicanus*, is perhaps not quite sure, so the systematic position of this species must continue to be regarded as doubtful.

Echinus elegans (p. 145). The specimens from Cape Verd (»Gazelle») noted by Studer as *Ech. elegans?*, are two small naked tests; one is doubtless *Genocidaris maculata*, the other I suppose to be a *Parechinus*, but it cannot be decided with certainty.

Echinus affinis (p. 152). For this species I can add one more locality, having found in the museum of Paris some specimens from 39° 38′ N. L. 70° 56′ W. L. 1241 fathoms (Blake); they were called *Ech. norvegicus*.

Echinus acutus, var. *norvegicus* (p. 155). Some small specimens from the Faroe Channel (Michael Sars 150—217 fathoms, Ad. S. Jensen) have a primary tubercle on all the ambulacral plates and upon the whole in regular series; they are only irregular as to size, especially a few ones at the ambitus being disproportionately large. Upon the whole the ambulacral areas have here quite the same appearance as in some specimens of *Ech. affinis*. They are then to be distinguished from this species by the colour and the globiferous pedicellariæ, the latter having in *affinis* 2—2 (more rarely 2—3) lateral teeth, while in *norvegicus* they have 1—1 or 1—2 lateral teeth. The tridentate pedicellariæ of the two species are so similar, that no distinguishing character can be found in this feature. On the other hand the spicules of the stalk of the pedicellariæ is a good character of *norvegicus* — when they are found, but they are no constant feature. — Evidently *Ech. affinis* is more particularly allied

to var. *norvegicus*, and they represent both of them transitional forms between the species with primary tubercle on every ambulacral plate and those with primary tubercle only on every other ambulacral plate. — The specimens of *norvegicus* mentioned here, have a specially small peristome, accordingly they belong to the form *microstoma*.

Echinus esculentus (p. 161). The specimens of this species from the Mediterranean found in Amsterdam and in British Museum, are correctly determined, but have been got from older collections, or bought from dealers in natural objects; consequently the locality is unreliable, and, as we have no other statements of the occurrence of this species in the Mediterranean, evidently wrong. This holds also good with regard to the specimens stated to be from Port Natal. The specimen after which the species is noted from the coasts of Spain and Portugal by Bell and Hoyle, is *Parechinus miliaris*. The specimen of *Ech. esculentus* (»Talisman«, Cape Spartel, 717 m.) mentioned by Bernard, is *Ech. elegans*. — The determinations by Bernard of the *Echinus* species, are otherwise quite confused: »*melo*» is *acutus*, »*norvegicus*» is *Alexandri*, »*acutus*» is a typical var. *norvegicus*. — The specimen from Brazil (John Adam's Bank) is stated to have been obtained by the »Herald»-Expedition; it is correctly determined, with a label within it; accordingly there can apparently be no doubt of the correctness. As we have not, however, other statements of the occurrence of the species off Brazil, I must for the present remain sceptical with regard to this statement. The other distribution of the species does not indicate that it should really be found off Brazil.

Through Prof. Bell I have received a new *Echinus*-species (from »Department in the course of fishing investigations»), taken west of Ireland (»Porcupine»-bank, 91 fathoms), 2 specimens.

Diameter.	Height.	Diameter.		Largest breadth.		Number of plates.		Longest spines.
		Peristome.	Apical area.	Ambulacral area.	Interambulacral area.	Ambulacral area.	Interambulacral area.	
57	45	20	12	13	20	c. 38	18	13
33	23	14	8	7	12	22—23	14	?

All the measures are in millimetres.

The test is almost globular, especially in the large specimen; the edge of the mouth not curved inward. There are spines on the buccal plates; numerous, rather thick plates in the buccal membrane. No ocular plates reach to the periproct. Only every other ambulacral plate has a primary tubercle; on the other plates there is a rather large secondary tubercle in the inner end and one a little outside of the primary series, near the pores; otherwise there are almost no tubercles in the ambulacral area. The pores reach quite to the edge of the area. Each interambulacral plate has a primary tubercle and moreover ca. 4—6 secondary ones, which are, however, far from filling the plate, so that the test looks rather naked. The primary series are distinct. Miliary tubercles numerous. On the actinal side the tubercles are placed much more closely. Here the spines are rather long, directed straight downward, not flat or widened at the point; the abactinal spines short and fine. Pedicellariæ and spicules quite as in *Ech. esculentus*. The colour of the preserved specimens white. — After a communication from the Rev. Canon A. M. Norman it is this species he has described as *Ech.*

esculentus var. *tenuispina* (p. 162), and so it gets the name of **Echinus tenuispinus** n. sp. It is, as seen by Norman, closely allied to *esculentus*, with which it agrees in the most important characters: primary tubercle only on every other ambulacral plate, and spines on the buccal plates; it is easily distinguished from the latter by having far fewer tubercles, among which the primary series are very distinct, and by its white colour — *esculentus* seems always to keep the colour in spirit. I am decidedly of opinion that it must be regarded as an independent species, not only as a variety of *esculentus*. It differs considerably as to habitus from this species, among whose forms I know no specimens with which it may be confounded. What I, above (p. 162), have interpreted as var. *tenuispinus*, is a peculiar form with short, fine spines, but with the usual colour of the test (from the Faroe Islands); accordingly it is not identical with Norman's var. *tenuispinus*.

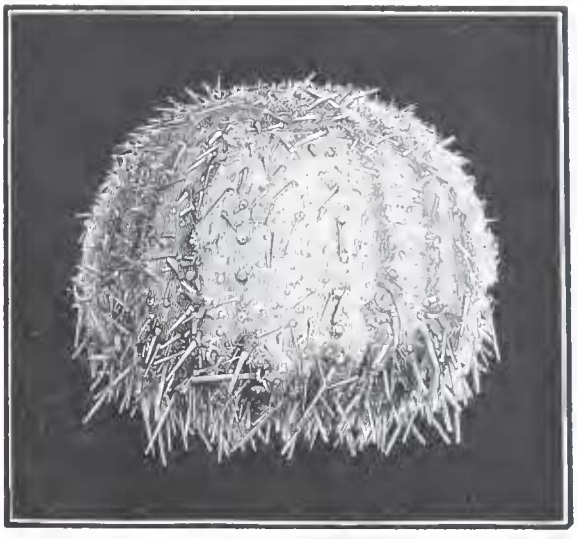

Fig. 12. *Echinus tenuispinus* n. sp. Natural size. (From a photograph.)

«*Strongylocentrotus lividus* (p. 165) is by Sluiter (371) mentioned from Dogger Bank — it is *Str. drobachiensis*.

Finally I shall call attention to the fact that no single regular Echinid belongs to the large cold depth north of Iceland. The account of the geographical distribution must otherwise be put off until the whole Echinid-material has been examined.

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The coloured figures are made from preserved specimens; nevertheless they give an excellent picture also of the living animals, the Echinids, as is well known (at all events with regard to a great number of species), being possessed of the excellent quality often to keep their colour completely in alcohol. — I have had occasion myself to see a great many living Echinids, so that I may have a well-founded opinion of this fact. — Only of *Calveria hystrix* I have had a coloured sketch, made from the living animal onboard of the »Ingolf»; the preserved animal proved to have lost next to nothing of the intensity of its colour. There is therefore good sense in making coloured figures from preserved specimens, especially as we have most frequently to do with preserved specimens by the determinations. I have accordingly thought it very important to have these figures made, and I must here take the opportunity to thank my friend, the artist painter, Mr. Bentzen-Bilkvist, most heartily for the excellent execution as well of the original figures as of the lithographic reproduction of these and of all the other plates. Also the uncoloured habitus figures are drawn by Mr. Bentzen-Bilkvist; all the detail figures are drawn by the author.

With regard to the enlargement (Obj. and Oc.) of the separate figures it must be noted that where nothing else is stated, a Seibert's microscope has been used; when a Zeiss's microscope has been used, it is specially stated.

Plate I.

Fig. 1. *Cidaris affinis.*

— 2—3. *Echinus elegans.*

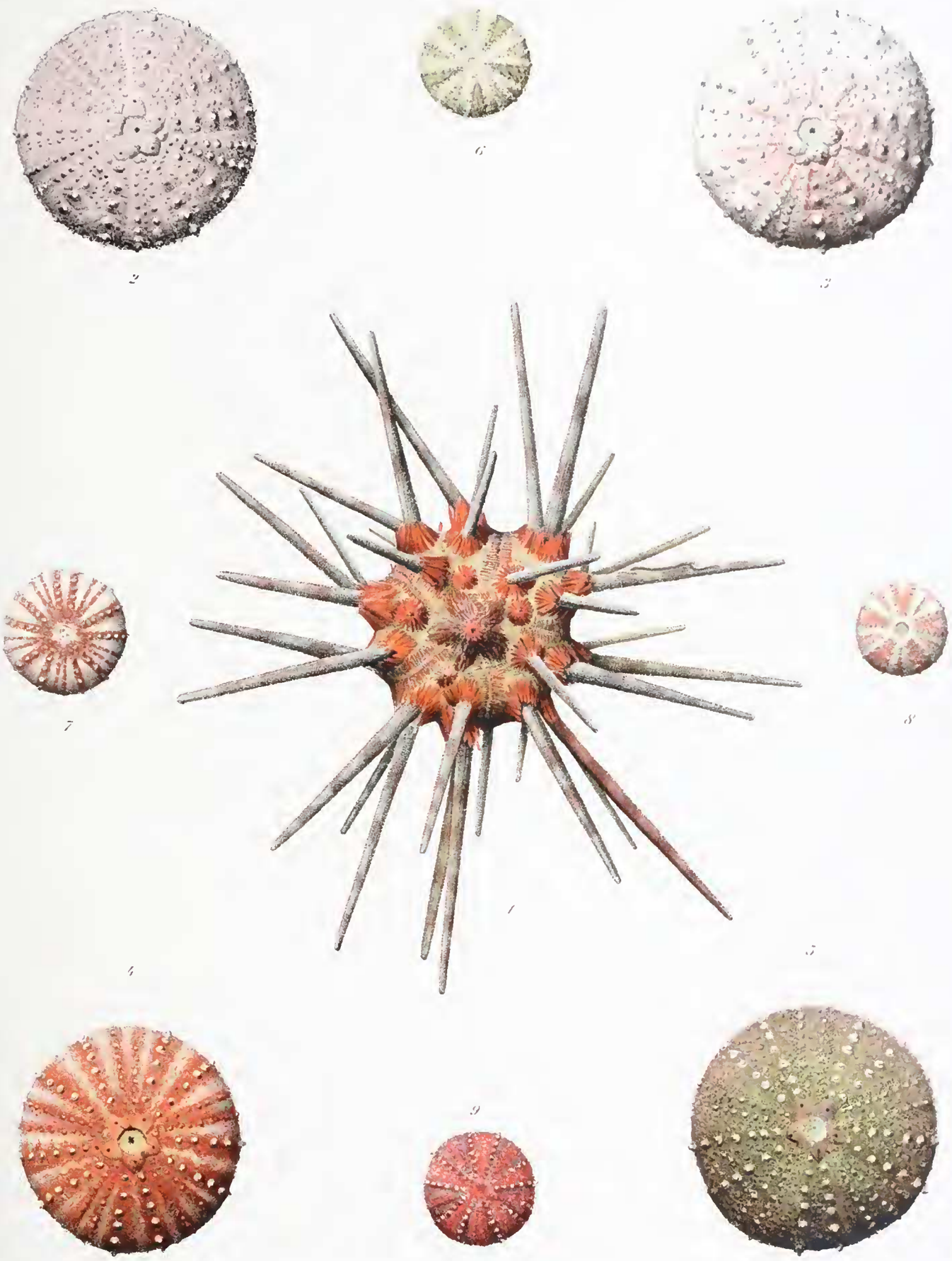
— 4. *Echinus acutus*, var. *norvegicus.*

— 5—6. *Strongylocentrotus drobachiensis.*

— 7. *Echinus acutus*, var. *Flemingii.*

— 8. *Echinus acutus*, var. *norvegicus.*

— 9. *Echinus esculentus*, young specimen.



1 Cidaris affinis Phil. 2-3. Echinus elegans DK 4,8 Ech norvegicus DK 5 6 Str drobachiensis (OFM.)
7 Ech Flemingii Forb. 9 Ech esculentus L.

Plate II.

Fig. 1. *Echinus acutus*, var. *Flemingii*.

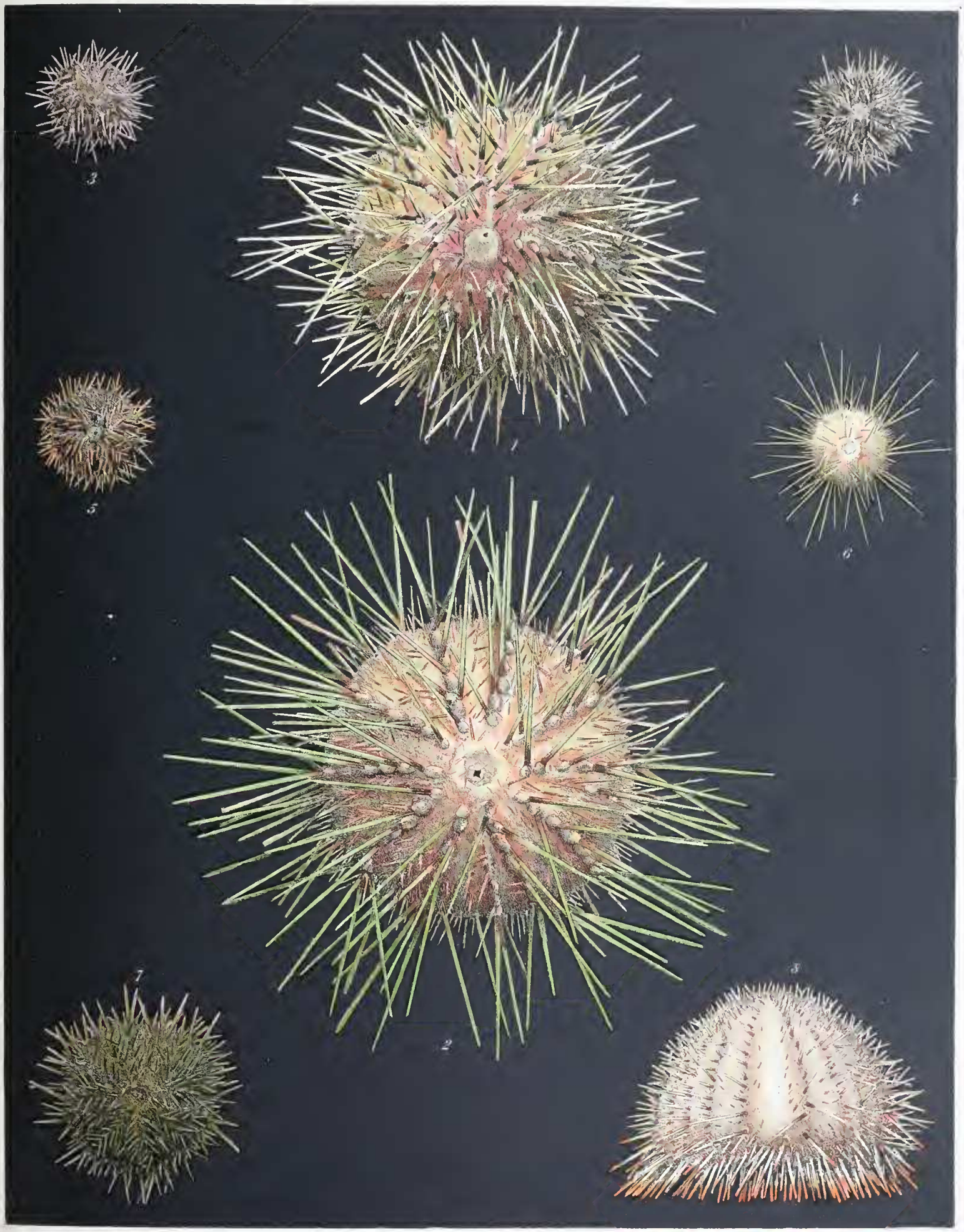
— 2. — — var. *norvegicus*, large specimen.

— 3—5. *Strongylocentrotus drøbachiensis*.

— 6. *Echinus acutus*, var. *norvegicus*, small specimen.

— 7. *Parechinus miliaris* (on the plate wrongly called *Psammechinus*).

— 8. *Echinus acutus*, var. *mediterranea*.



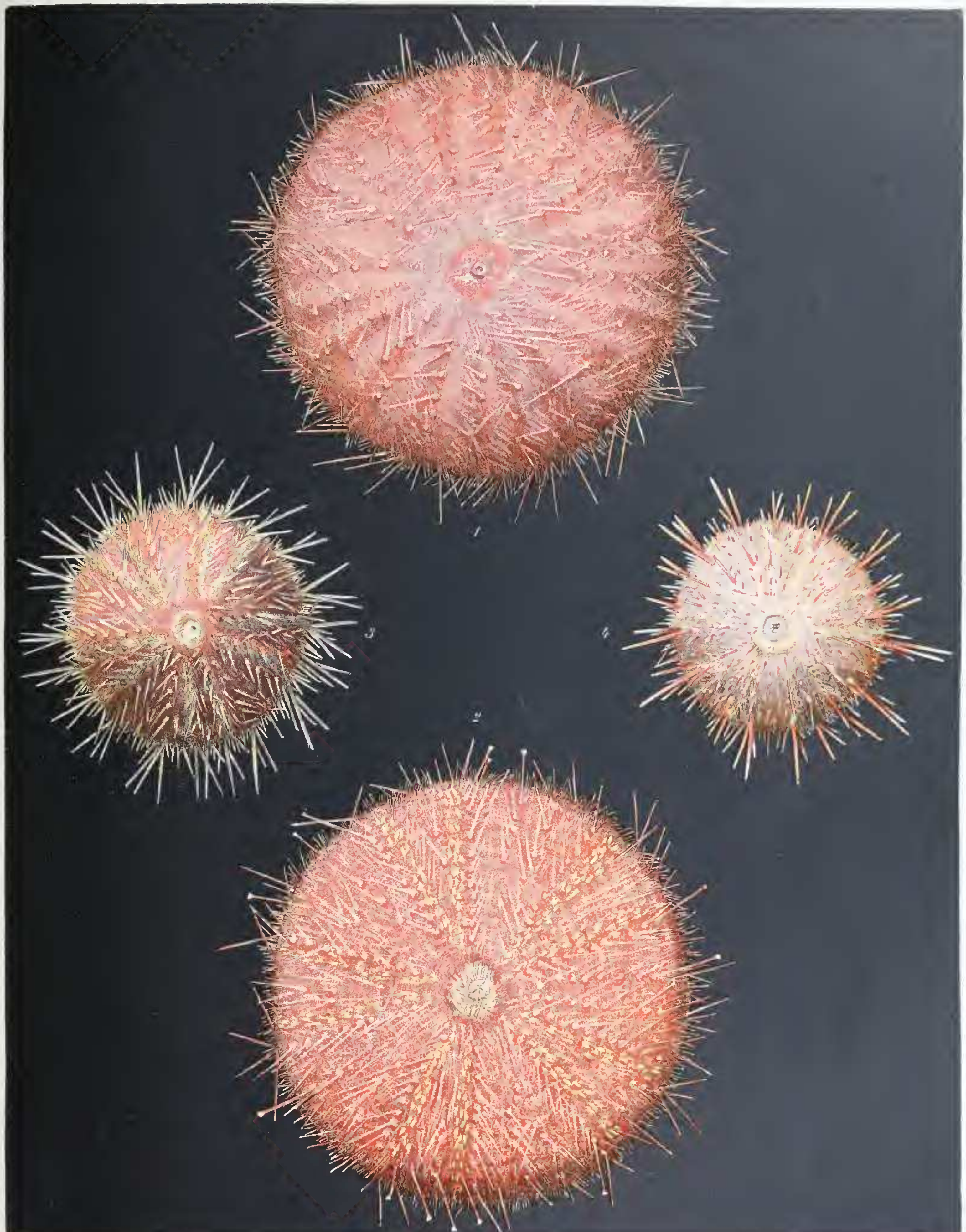
1 Echinus Flemingii Forb. 2,6 Ech. norvegicus D.K. 3 5 Str. drobachiensis (O.F.M.)
7. Psammech. miliaris (Müll.) 8. Ech. acutus Lam.

Plate III.

Fig. 1—2. *Calveria hystrix*, 1. abactinal side, 2. actinal side. (On the plate wrongly called »*Asthenosoma*«.)

— 3. *Echinus esculentus.*

— 4. — *elegans.*



1. 2. *Asthenosoma hystrix* (W. Th.) 3. *Echinus esculentus* L.
4. *Ech. elegans* D. K.

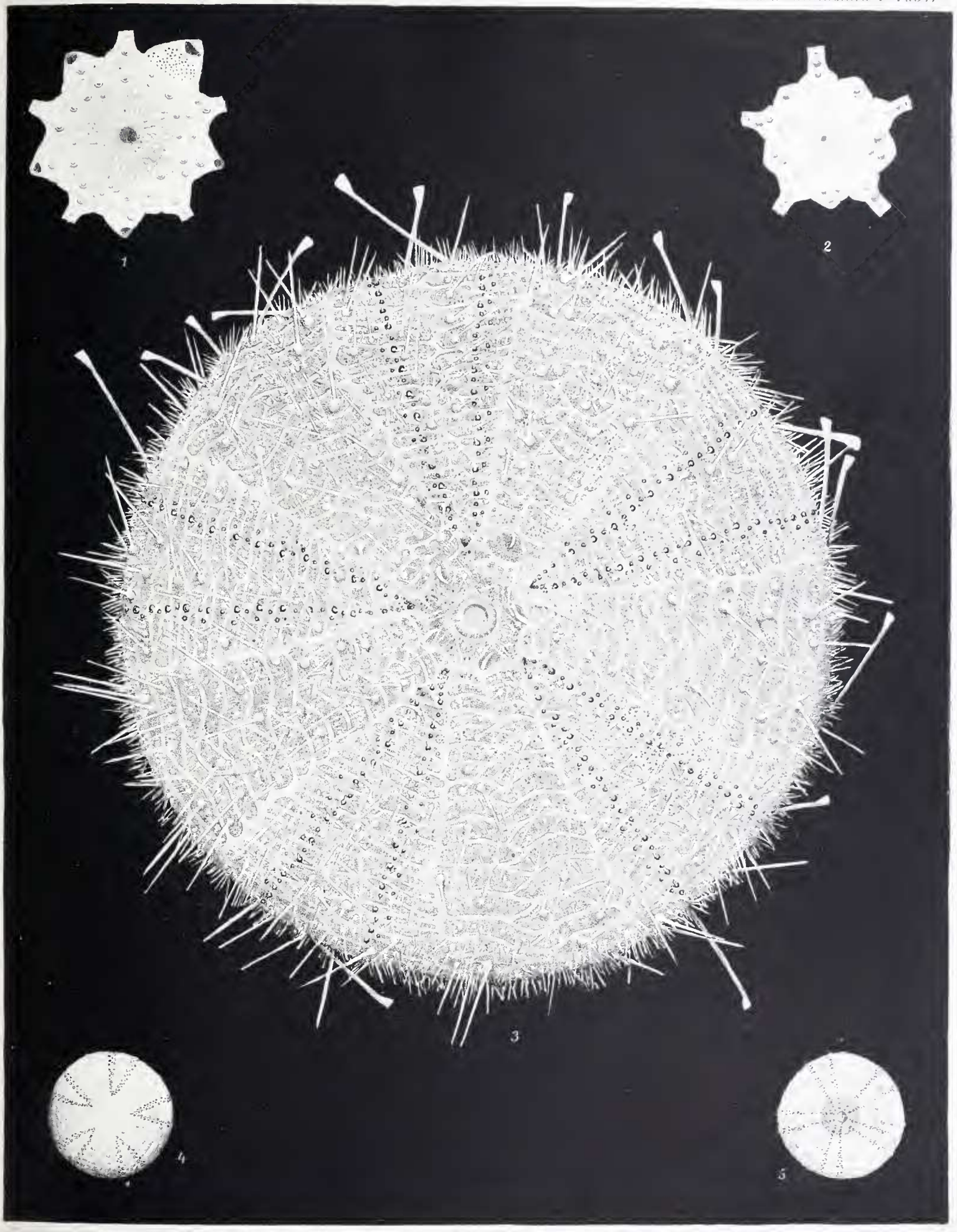
Plate IV.

Fig. 1. Apical area of *Phormosoma placenta*, diameter 37^{mm}. $^{4}/_{1}$.

— 2. — - - — — — 7^{mm}. $^{8}/_{1}$.

— 3. *Sperosoma Grimaldii*, abactinal side.

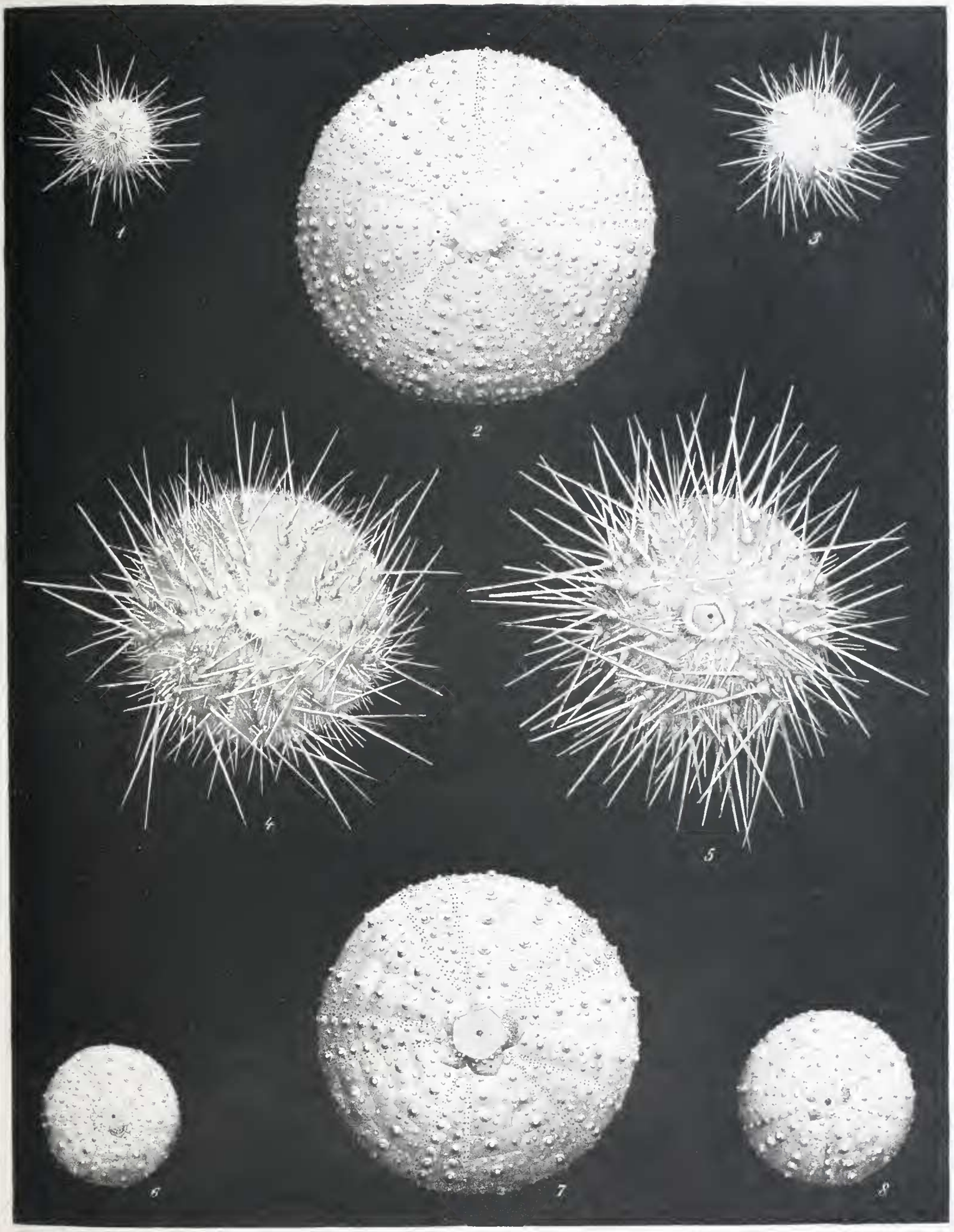
— 4–5. — — young specimen; 4. abactinal side, 5. actinal side.



1 2 Phormosoma placenta W Th 3 5 Sperosoma Grimaldii Koehler.

Plate V.

Fig. 1. *Hypsiechinus coronatus.* $^{2}/_{1}$.
— 2—3. *Echinus Alexandri.* $^{1}/_{1}$.
— 4. — *affinis.* $^{1}/_{1}$.
— 5—7. — *Alexandri.* $^{1}/_{1}$.
— 8. — *affinis.* $^{1}/_{1}$.



1 Hypsechinus coronatus n. g. n. sp. 2, 3, 5, 7 Echinus Alexandri Pan. Kor. 4, 8 Ech. Affinis n. sp.

Plate VI.

Fig. 1. *Stereocidaris ingolfiana*, from above. $^{1}/_{1}$.

— 2. — — - the side. $^{1}/_{1}$.

— 3. Test of *Stereocidaris ingolfiana*. $^{1}/_{1}$.

— 4. Apical area of — — $^{2}/_{1}$.

— 5. Ambulacral-processes of *Stereocidaris ingolfiana*. $^{1}/_{1}$.

— 6. — - *Dorocidaris papillata*. $^{1}/_{1}$.

— 7. Interambulacral area - — — $^{1}/_{1}$.

— 8. Piece of ambulacral area of *Dorocidaris papillata*. $^{4}/_{1}$.

— 9. — - — - *Cidaris affinis*. $^{4}/_{1}$.

— 10. Interambulacral area of *Cidaris affinis*. $^{2}/_{1}$.

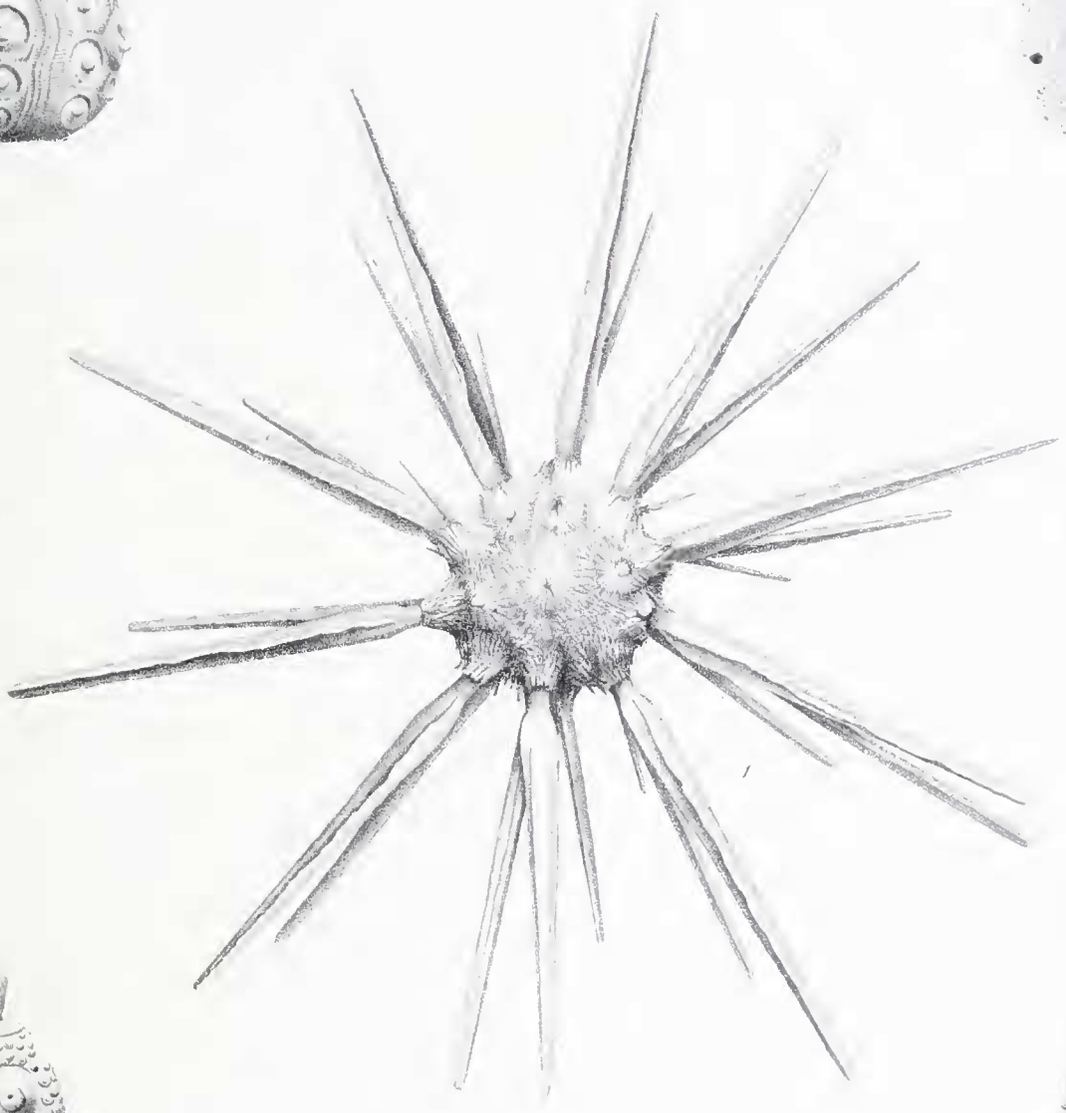
— 11. Piece of ambulacral area of *Stereocidaris ingolfiana*. $^{4}/_{1}$.

— 12. — - — - *Porocidaris purpurata*. $^{4}/_{1}$.

2

3

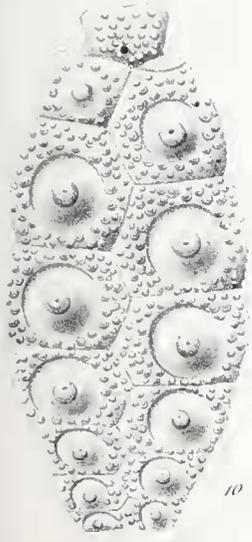
4



1

6

5



10

9

8

11

12

7

1 5, 11 Stereocidaris ingolfiana n.sp. 6 8 Dorocidaris papillata (Leske) 9 10 Cidaris affinis Phil
12 Porocidaris purpurata W Th

Plate VII.

Fig. 1—20. *Hypsiechinus coronatus.*

— 1. Test of ♀. $^4/_1$.

— 2—4. Test of ♀. $^1/_1$.

— 5. Specimen with young. $^3/_1$.

— 6—8. Three developmental stages, the more important skeletal parts begun. Obj. II. Oc. I.

— 9. Apical area of ♂. $^4/_1$.

— 10. Piece of the rosette. Obj. II. Oc. III.

— 11. Plate from the buccal membrane. Obj. II. Oc. I.

— 12. Spicules from the gills. Obj. II. Oc. I.

— 13. Spicules from tube feet. Obj. II. Oc. I.

— 14. Anal plate of a young one. Obj. II. Oc. III.

— 15. Calcareous plates from the buccal membrane, inside of the buccal plates. Obj. II. Oc. I.

— 16. Valve of triphyllous pedicellaria. Obj. II. Oc. III.

— 17. Sphæridia. Obj. II. Oc. III.

— 18. Valve of ophicephalous pedicellaria. Obj. II. Oc. III.

— 19. — - globiferous pedicellaria, from the inside. Obj. II. Oc. III.

— 20. — - — — — - side. Obj. II. Oc. III.

— 21. — - tridentate pedicellaria of *Prionechinus sagittiger.* Obj. II. Oc. I.

— 22. — - — - *Arbacina forbesiana.* Obj. II. Oc. I.

— 23. — - triphyllous — - *Trigonocidaris albida.* Obj. II. Oc. III.

— 24. — - — — - *Genocidaris maculata.* Obj. II. Oc. III.

— 25. — - — — - *Prionechinus sagittiger.* Obj. II. Oc. III.

— 26. — - — — - *Arbacina forbesiana.* Obj. II. Oc. III.

— 27. Spicules from tube foot of *Trigonocidaris monolini.* Obj. V. Oc. o.

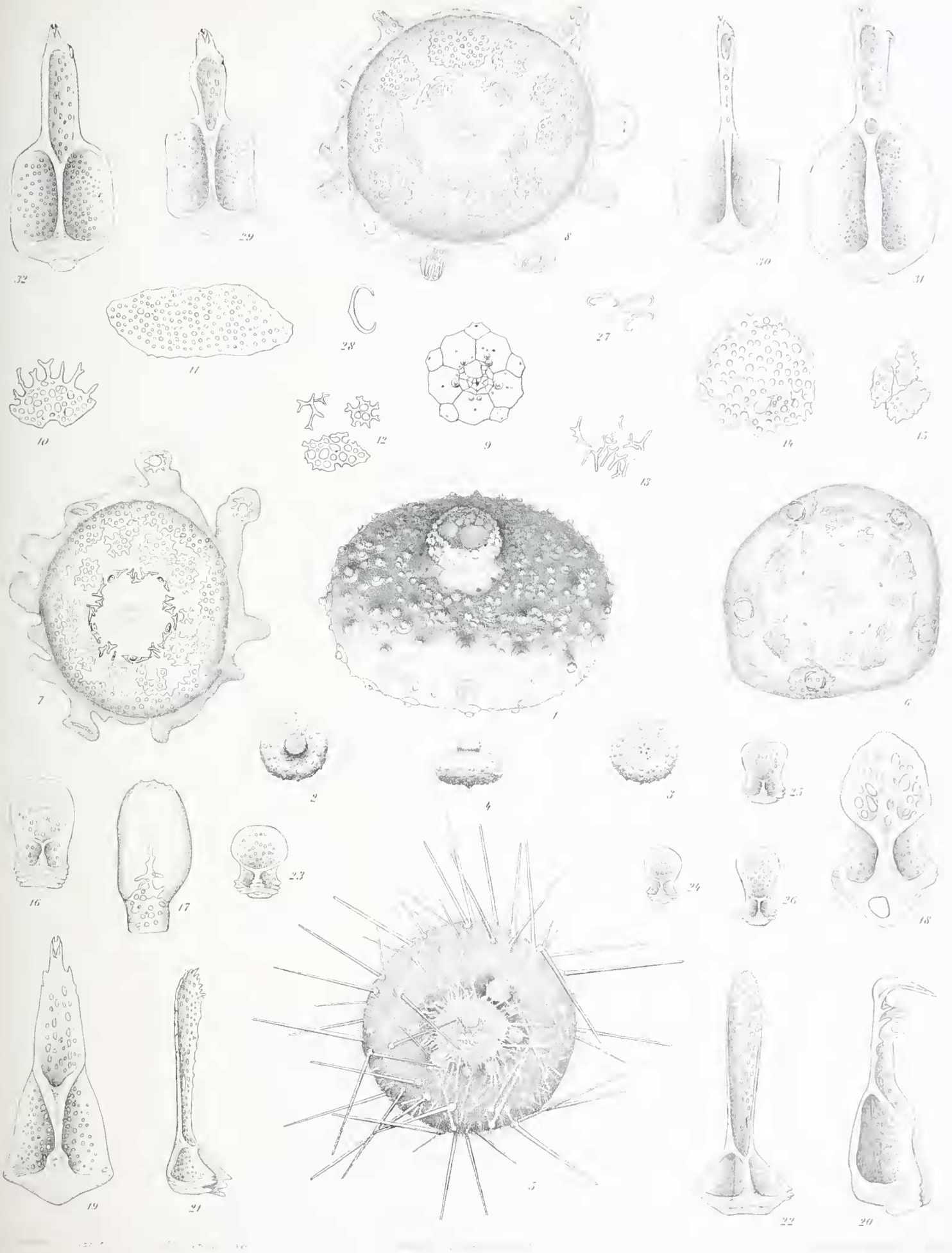
— 28. — - — — - — *albida.* Obj. V. Oc. o.

— 29. Valve of globiferous pedicellaria of *Prionechinus sagittiger.* Obj. II. Oc. III.

— 30. — - — — - *Genocidaris maculata.* Obj. II. Oc. III.

— 31. — - — — - *Trigonocidaris albida.* Obj. II. Oc. III.

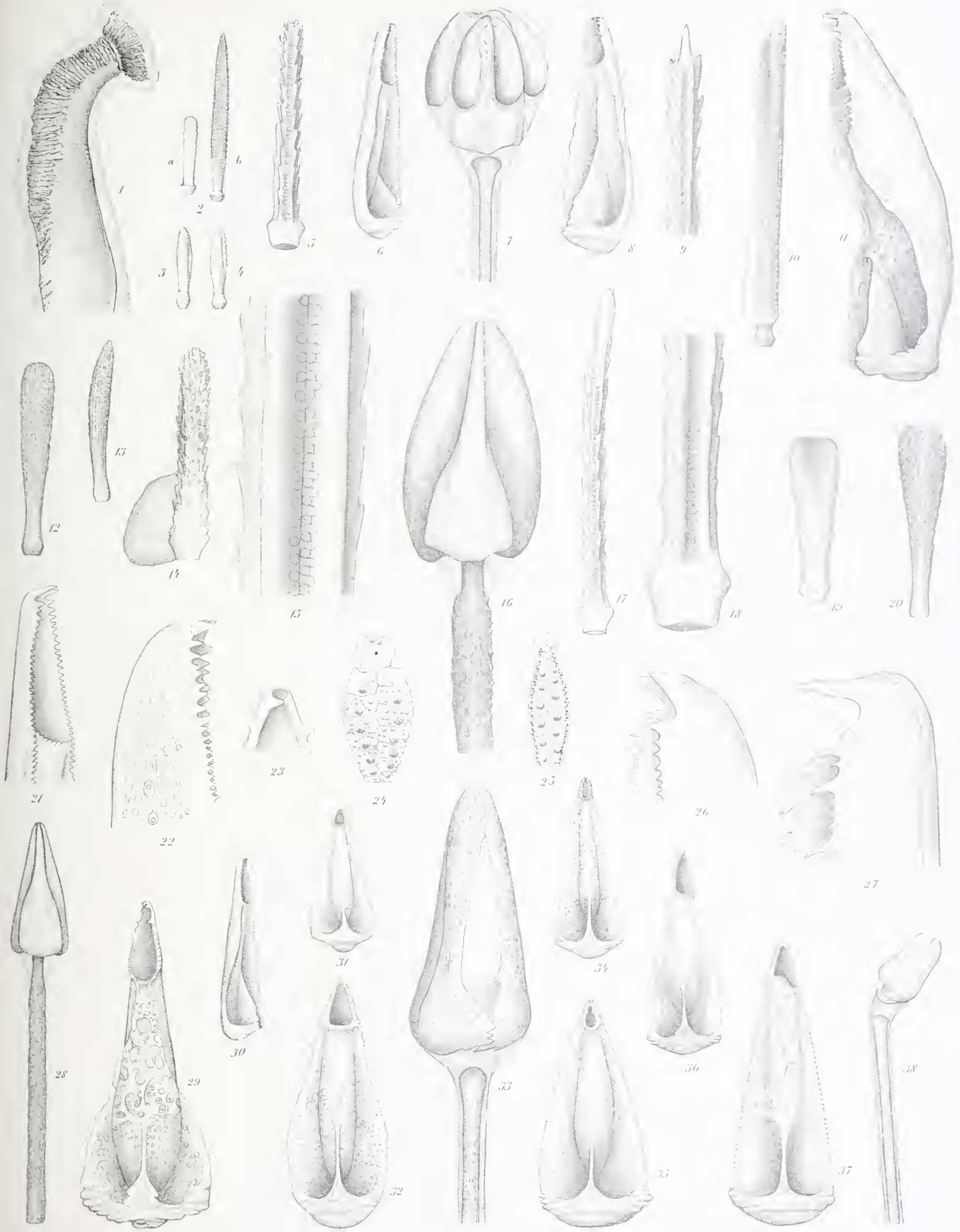
— 32. — - — — - *Arbacina forbesiana.* Obj. II. Oc. III.



1–20 Hypsiechinus coronatus n.g., n.sp. 21–32 Prionechinus, Trigonocidaris, Genocidaris, Arbacina

Plate VIII.

Fig. 1. Tube foot of *Dorocidaris papillata*, shows the arrangement of the spicules. Obj. 0. Oc. 0.
— 2. a. b. Spines of *Cidaris affinis* (U. S. F. C.); a. primary actinal spine, $^3/_1$. b. primary abactinal spine, $^1/_1$.
— 3. Actinal primary spine of *Dorocidaris papillata*. $^1/_1$.
— 4. — — - - *Stereocidaris ingolfiana*. $^2/_1$.
— 5. Secondary abactinal spine of *Hypsiechinus coronatus*. Obj. II. Oc. 0.
— 6. Valve of a small globiferous pedicellaria of *Stereocidaris canaliculata*, from the side. Obj. II. Oc. I.
— 7. Globiferous pedicellaria of *Genocidaris maculata*; shows the double poison gland. Obj. II. Oc. I.
— 8. Valve of a large globiferous pedicellaria of *Stereocidaris canaliculata*, from the side. Obj. II. Oc. I.
— 9. Point of a primary abactinal spine of *Hypsiechinus coronatus*. Obj. II. Oc. 0.
— 10. Primary abactinal spine of *Stereocidaris ingolfiana*. $^1/_1$.
— 11. Valve of a large globiferous pedicellaria of *Stereocid. ingolfiana*, from the side. Obj. II. Oc. I.
— 12. Spine from the peristome of *Dorocid. papillata*. Obj. 00. Oc. 0.
— 13. — - — - — — from the side. Obj. 00. Oc. 0.
— 14. Secondary spine with ampulla from the abactinal side of *Dorocid. papillata*. Obj. 0. Oc. 0.
— 15. Piece of an actinal spine of *Hypsiech. coronatus*. Obj. II. Oc. III.
— 16. Large globiferous pedicellaria of *Stereocidaris ingolfiana*. Obj. II. Oc. 0.
— 17. Actinal spine of *Hypsiech. coronatus*. Obj. 0. Oc. 0.
— 18. Piece of an abactinal primary spine of *Hypsiech. coronatus*. Obj. II. Oc. 0.
— 19. Secondary spine of *Stereocidaris ingolfiana*. Obj. 00. Oc. 0.
— 20. Spine from the peristome of — — Obj. 0. Oc. 0.
— 21. Point of a valve of a small globiferous pedicellaria of *Stereocid. ingolfiana*. Obj. V. Oc. I.
— 22. — - — — pedicellaria of *Porocidaris purpurata*. Obj. V. Oc. 0.
— 23. — - — — small globiferous pedicellaria of *Sterocid. ingolfiana*. The two outermost teeth coalesced in the point. Obj. V. Oc. III.
— 24—25. Ambulacral and interambulacral area of *Hypsiechinus coronatus*. $^4/_1$. The sutures of the ambulacral area are not so distinct in the animal, as here in the figure.
— 26. Point of a valve of a large globiferous pedicellaria of *Stereocid. ingolfiana*. Obj. V. Oc. 0.
— 27. — - — - — — — - *Dorocid. papillata*. Obj. V. Oc. 0.
— 28. Small globiferous pedicellaria of *Stereocid. ingolfiana*. Obj. II. Oc. 0.
— 29. Valve of a large globiferous pedicellaria of *Stereocid. ingolfiana*, from the inside. Obj. II. Oc. I.
— 30. — - - small — - — — - side. Obj. II. Oc. I. (comp. Fig. 21.)
— 31. Valve of a globiferous pedicellaria of *Stereocidaris incerta*. Obj. A A. Oc. III. (Zeiss.)
— 32. — - - large globiferous pedicellaria of *Stereocid. canaliculata*, from the inside. Obj. II. Oc. I.
— 33. Tridentate pedicellaria of *Arbacina forbesiana*. Obj. II. Oc. I.
— 34. Valve of small globiferous pedicellaria of *Stereocid. Mortenseni*, from the inside. A A. Oc. I. (Zeiss.)
— 35. — - large — — - — sp., from the inside. (Challenger. St. 156. comp. p. 26.) Obj. II. Oc. 0.
— 36. Valve of small globiferous pedicellaria of *Stereocid. ingolfiana*, from the inside. Obj. II. Oc. I.
— 37. — - large — — - *Acanthocidaris curvatispinis*, from the inside. Obj. II. Oc. I.
— 38. Ophicephalous pedicellaria of *Hypsiechinus coronatus*. Obj. II. Oc. 0.



Cidaridae Temnopleuridae

Plate IX.

Fig. 1. Valve of tridentate pedicellaria of *Cidaris affinis*, from the side. Obj. II. Oc. III.

— 2. — - small globiferous pedicellaria of *Histocidaris elegans* (?), from the side. Obj. II. Oc. I. (See Appendix.)

— 3. Valve of large globiferous — - *Dorocidaris papillata*, - — Obj. II. Oc. o.

— 4. Stalk - — — — - *Tretocidaris annulata*. Obj. II. Oc. o.

— 5. Valve - — — — - *Dorocid. papillata*, from the inside. Obj. II. Oc. o.

— 6. — - small — — - *Phyllacanthus imperialis*, from the side. Obj. II. Oc. III.

— 7. Valve of tridentate — - *Dorocid. papillata*, from the side. Obj. II. Oc. o.

— 8. — - small globiferous — - *Cidaris affinis* (U. S. F. C.), from the inside Obj. II. Oc. III.

— 9. Valve of large — — - — — from the side. Obj. II. Oc. I.

— 10. — - small — — - *Goniocidaris biserialis*, from the side. Obj. II. Oc. III.

— 11. — - — — — - *Cidaris affinis* (U. S. F. C.), from the side. Obj. II. Oc. III.

— 12. Stalk of large — — - — — Obj. II. Oc. I.

— 13. Valve - small — — - *Dorocid. papillata*, from the side. Obj. II. Oc. I. (Comp. Fig. 20.)

— 14. Valve of small — — - — — f. *abyssicola*, from the inside. Obj. AA. Oc. III. (Zeiss.)

— 15. Valve of small globiferous — - — — from the inside. Obj. II. Oc. III.

— 16. — - large — — - — *Blakei*, from the nside. Obj. II. Oc. o.

— 17. Point of a valve of a small globiferous pedicellaria of *Cidaris affinis* (U. S. F. C.). Obj. V. Oc. I.

— 18. Valve of tridentate pedicellaria of *Cidaris affinis* (U. S. F. C.), from the inside. Obj. II. Oc. I.

— 19. — - — — - — — — - the side. Obj. II. Oc. I.

— 20. Point of a valve of a small globiferous pedicellaria of *Dorocid. papillata*. Obj. V. Oc. o.

— 21. Tridentate pedicellaria of *Cidaris affinis* (U. S. F. C.). Obj. II. Oc. o.

— 22. Valve of a large globiferous pedicellaria of *Cidaris affinis*, from the inside. Obj. II. Oc. I.

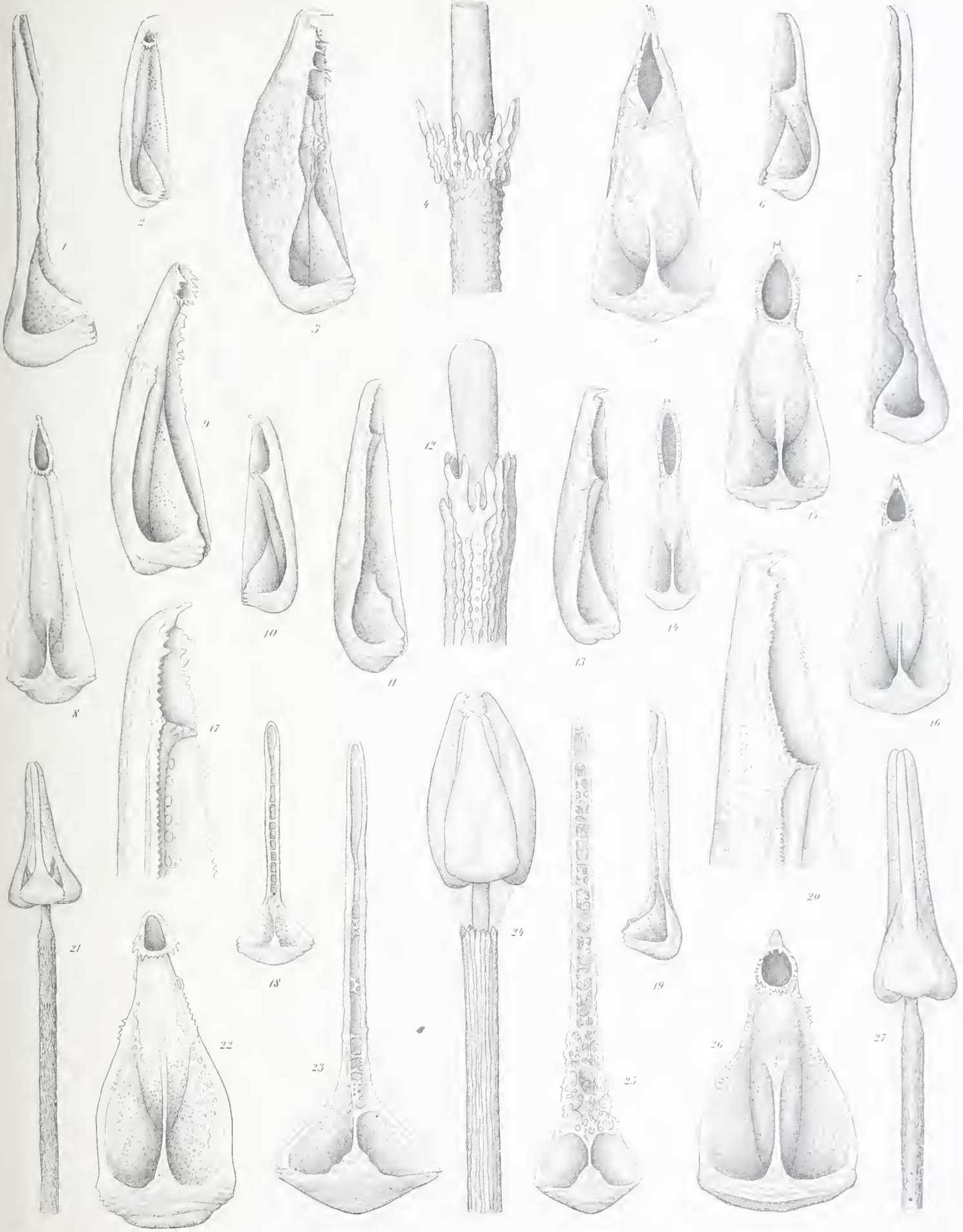
— 23. — - tridentate — - — — - — Obj. II. Oc. III.

— 24. Large globiferous pedicellaria of *Cidaris affinis*. Obj. o. Oc. I.

— 25. Valve of tridentate pedicellaria of *Dorocid. papillata*, from the inside. Obj. II. Oc. o.

— 26. — - large globiferous pedicellaria of *Dorocid.* (?) *micans*, from the inside. Obj. II. Oc. o.

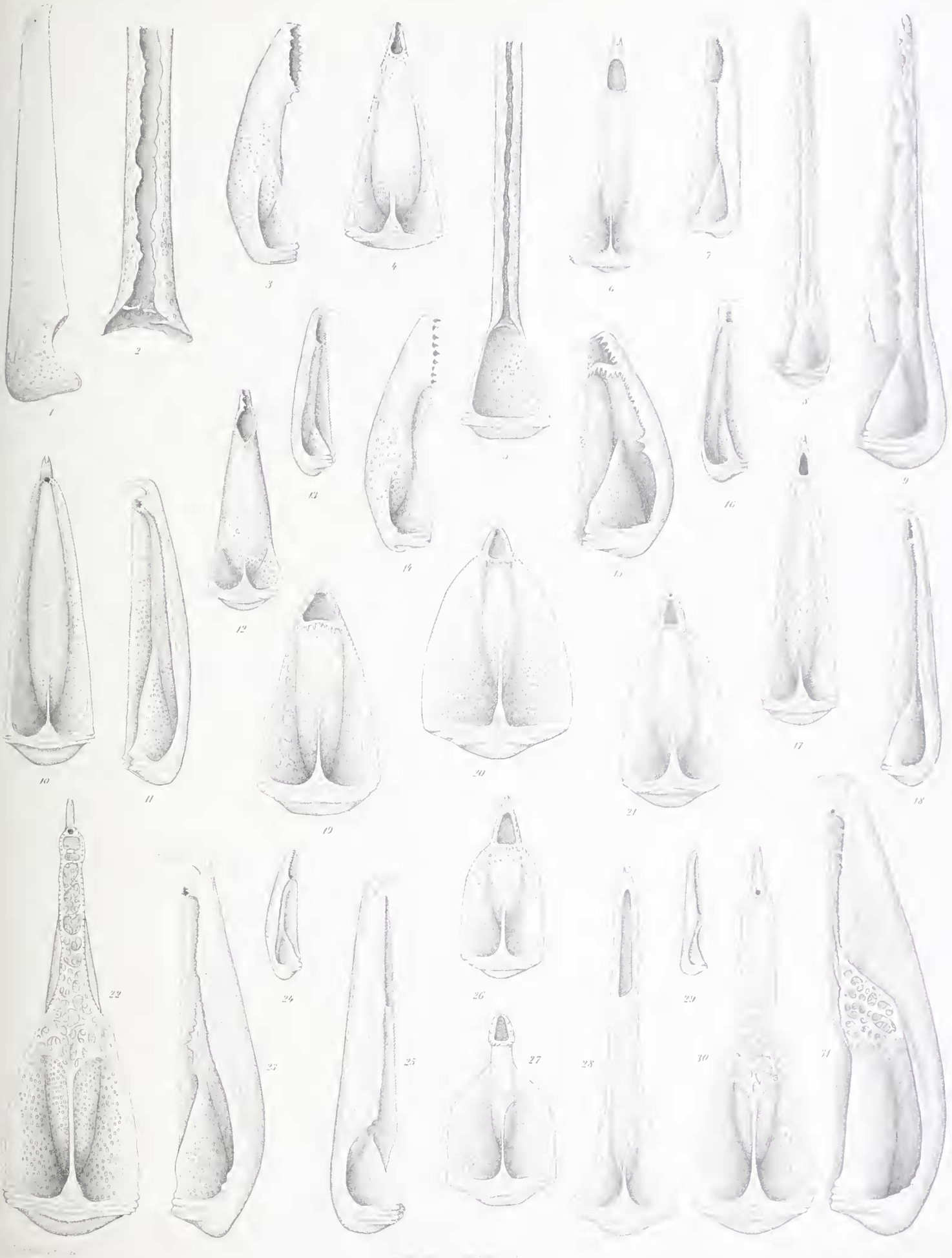
— 27. Tridentate pedicellaria of *Dorocid. papillata*. Obj. o. Oc. I.



Cidarida

Plate X.

Fig. 1. Valve of pedicellaria of *Porocidaris purpurata*, from the side. Obj. II. Oc. 0.
— 2. Piece of the same, from the inside. Obj. V. Oc. 0.
— 3. Valve of a large globiferous pedicellaria of *Stereocidaris nutrix*, from the side. Obj. II. Oc. 0.
— 4. — — — — — - — — - the inside. Obj. II. Oc. 0.
— 5. — of pedicellaria of *Porocidaris purpurata*, from the inside, the lower part. Obj. II. Oc. 0.
— 6. — - globiferous pedicellaria of *Discocidaris* (?) *serrata*, from the inside. Obj. II. Oc. III.
— 7. — - — — - — — - the side. Obj. II. Oc. III.
— 8. — - tridentate — - *Phyllacanthus imperialis*, from the side. Obj. A A. Oc. I (Zeiss.)
— 9. Valve of tridentate — - *Acanthocidaris curvatispinis*, from the side. Obj. A A. Oc. I. (Zeiss.)
— 10. Valve of a large globiferous pedicellaria (a smaller specimen) of *Tretocidaris spinosa*, from the inside. Obj. II. Oc. 0.
— 11. Valve of a large globiferous — of *Tretocidaris spinosa*, from the side. Obj. II. Oc. 0.
— 12. — — — — — - *Stereocidaris nutrix*, - the inside. Obj. II. Oc. 0.
— 13. — — small — — - *Goniocidaris umbraculum*, from the side. Obj. II. Oc. I.
— 14. — — large — — - *Stereocidaris nutrix*, from the side. Obj. II. Oc. 0.
— 15. — — — — — - *Chondrocidaris gigantea*, from the side. Obj. II. Oc. I.
— 16. — — small — — - *Tretocidaris spinosa*, from the side. Obj. II. Oc. 0.
— 17. — — large — — - *Stephanocidaris bispinosa* (see Appendix), from the inside. Obj. II. Oc. 0.
— 18. Valve of a large globiferous — - *Stephanocidaris bracteata*, from the side. Obj. II. Oc. I.
— 19. — — — — — - *Chondrocidaris gigantea*, from the inside. Obj. II. Oc. I.
— 20. — — — — — - *Goniocidaris tubaria*, - — Obj. II. Oc. I.
— 21. — — — — — - — *umbraculum*, - — Obj. II. Oc. I.
— 22. — — — — — - *Tretocidaris annulata*, - — Obj. II. Oc. 0.
— 23. — — — — — - — *Bartletti*, from the side. Obj. A A. Oc. VI. (Zeiss.)
— 24. Valve of a small — — - *Stereocidaris nutrix*, - — Obj. A A. Oc. III. (Zeiss.)
— 25. Valve of a large — — - *Schizocidaris assimilis*, - — Obj. II. Oc. III.
— 26. — — small — — - *Chondrocidaris gigantea*, from the inside. Obj. AA. Oc. VI. (Zeiss.)
— 27. Valve of a large — — - *Petalocidaris florigera*, - — Obj. A A. Oc. VI. (Zeiss.)
— 28. Valve of a large — — - *Schizocidaris assimilis*, - — Obj. II. Oc. III.
— 29. Valve of a small — — - *Petalocidaris florigera*, from the inside. Obj. II. Oc. I.
— 30. — — large — — - *Tretocidaris Bartletti*, — — Obj. A A. Oc. VI. (Zeiss.)
— 31. Valve of a large — — - — *annulata*, — the side. Obj. II. Oc. 0.



Cidaridæ

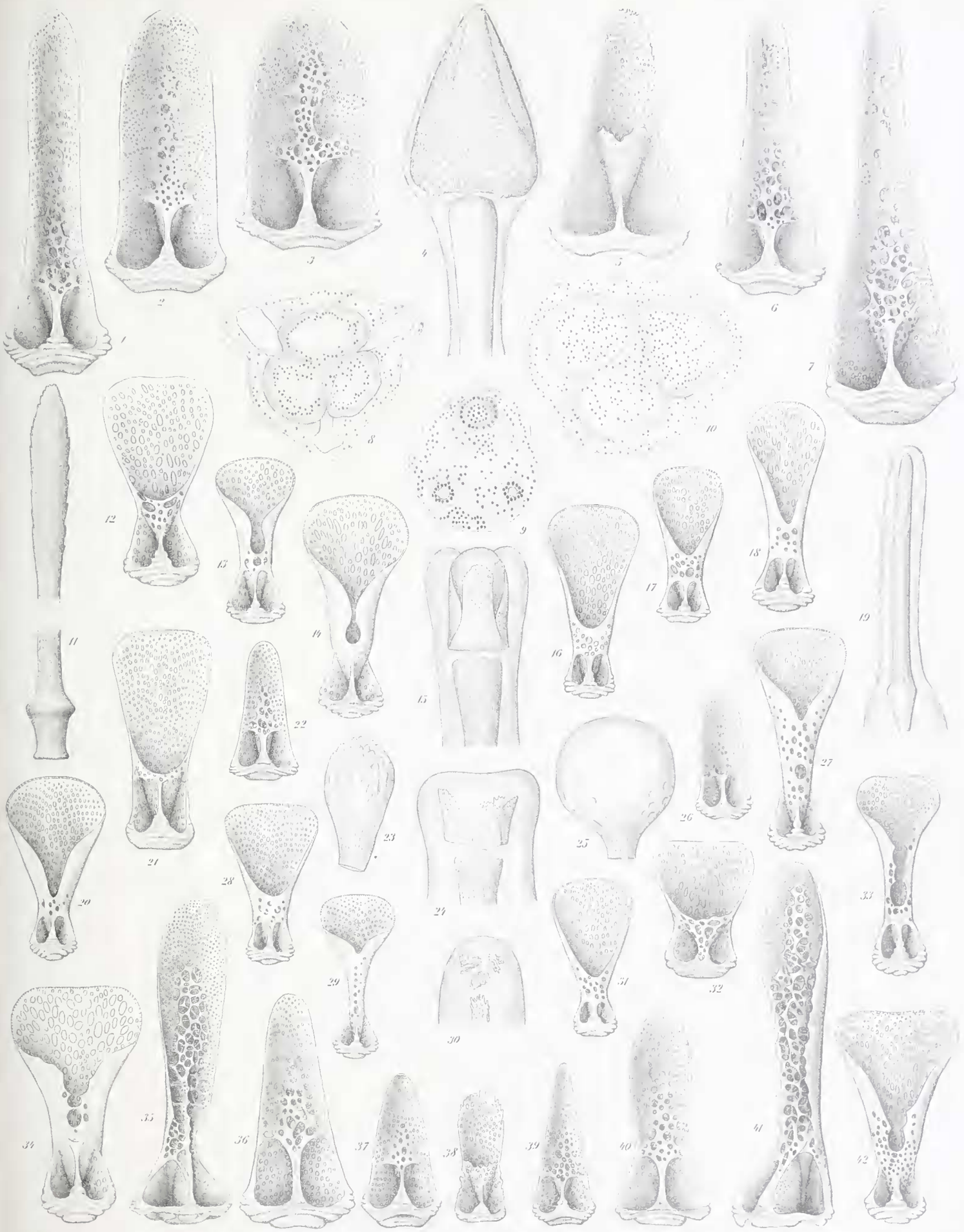
Plate XI.

Fig. 1. Piece of transverse section of a primary spine of *Cidaris affinis*. Obj. II. Oc. 0.
— 2. — - — — - spines of *Tromikosoma Kochleri*; a—b. sections of primary actinal spines, c. of an abactinal spine. Obj. II. Oc. I.
— 3. Piece of transverse section of a primary spine of *Porocidaris purpurata*. Obj. II. Oc. I.
— 4. — - — — - spines of *Hygrosoma Petersii*; a. section of a primary actinal spine, b. of an abactinal spine. Obj. II. Oc. I.
— 5. Piece of transverse section of spines of *Calveria hystrix*; a. section of a primary actinal spine, b. of an abactinal spine. Obj. II. Oc. I.
— 6. Transverse section of a primary spine of *Hypsiechinus coronatus*. Obj. II. Oc. III.
— 7. Piece of transverse section of spines of *Phormosoma placenta*; a. section of an abactinal spine, b. of a primary actinal spine, lower part. Obj. II. Oc. I.
— 8. Piece of transverse section of a primary spine of *Arœosoma fenestratum*. Obj. II. Oc. I.
— 9. — - — — - spines of *Sperosoma Grimaldii*; a. section of a primary actinal spine, b. of an abactinal spine. Obj. II. Oc. I.
— 10. Transverse section of a primary actinal spine of *Phormosoma placenta*, outer part. The outline indicates the circumference of the bag of skin. Obj. II. Oc. I.
— 11. Spicule of a tube foot of *Arœosoma tesselatum*. Obj. II. Oc. III.
— 12. a. b. Spicules from the organs of Stewart of *Stereocidaris ingolfiana*. Obj. II. Oc. I.
— 13. Spicules of a tube foot of *Tromikosoma Koehleri*. Obj. II. Oc. I.
— 14. Piece of transverse section of a primary spine of *Dorocidaris papillata*, young specimen. Obj. II. Oc. 0.
— 15. Spicules of a tube foot of *Arœosoma coriaceum*; a. from the outer, b. from the lower part Obj. II. Oc. III.
— 16. a—d. Spicules of the genital organs of *Stereocidaris ingolfiana*. Obj. II. Oc. I.
— 17. Piece of a primary spine of a young *Stereocidaris ingolfiana*. Obj. 00. Oc. 0.
— 18. Spicules of a tube foot, lower part, of *Kamptosoma asterias* (*Ph. tenue*. Chall. St. 272). Obj. II. Oc. I.
— 19. Spicules of a tube foot of *Hapalosoma pellucidum*. Obj. II. Oc. III.
— 20. — — — - *Asthenosoma varium*. Obj. II. Oc. III.
— 21. — — — - *Porocidaris purpurata*. Obj. II. Oc. I.
— 22. — — — - *Cidaris affinis*; a. from the outer, b—c. from the lower part. Obj. II. Oc. I.
— 23. Piece of the intestine, with imbedded spicules, of *Stereocidaris ingolfiana*. Obj. II. Oc. I.
— 24. — - transverse section of a primary spine of *Dorocidaris* (?) *micans*. Obj. II. Oc. I.
— 25. Spicules of an abactinal tube foot of *Phormosoma placenta*. Obj. II. Oc. I.
— 26. a—d. — of a tube foot of *Dorocidaris papillata*. Obj. II. Oc. III.
— 27. — — — - *Hygrosoma Petersii*. Obj. II. Oc. I.
— 28. a—d. — — — - *Stereocidaris ingolfiana*. Obj. II. Oc. III.
— 29. — — — - *Calveria hystrix*. Obj. II. Oc. III.
— 30. Piece of a primary spine with the crest of a young *Stereocidaris ingolfiana*. Obj. 00. Oc. 0.
— 31. — - transverse section of a primary spine of *Dorocidaris papillata*, larger specimen. Obj. II. Oc. 0.
— 32. Piece of the crest of a primary spine of *Stereocidaris ingolfiana*. Obj. II. Oc. 0.
— 33. — - transverse section of a primary spine of *Stereocidaris ingolfiana*. Obj. II. Oc. I.

Cidaridæ. Echinothuridæ. Temnopleuridæ.

Plate XII.

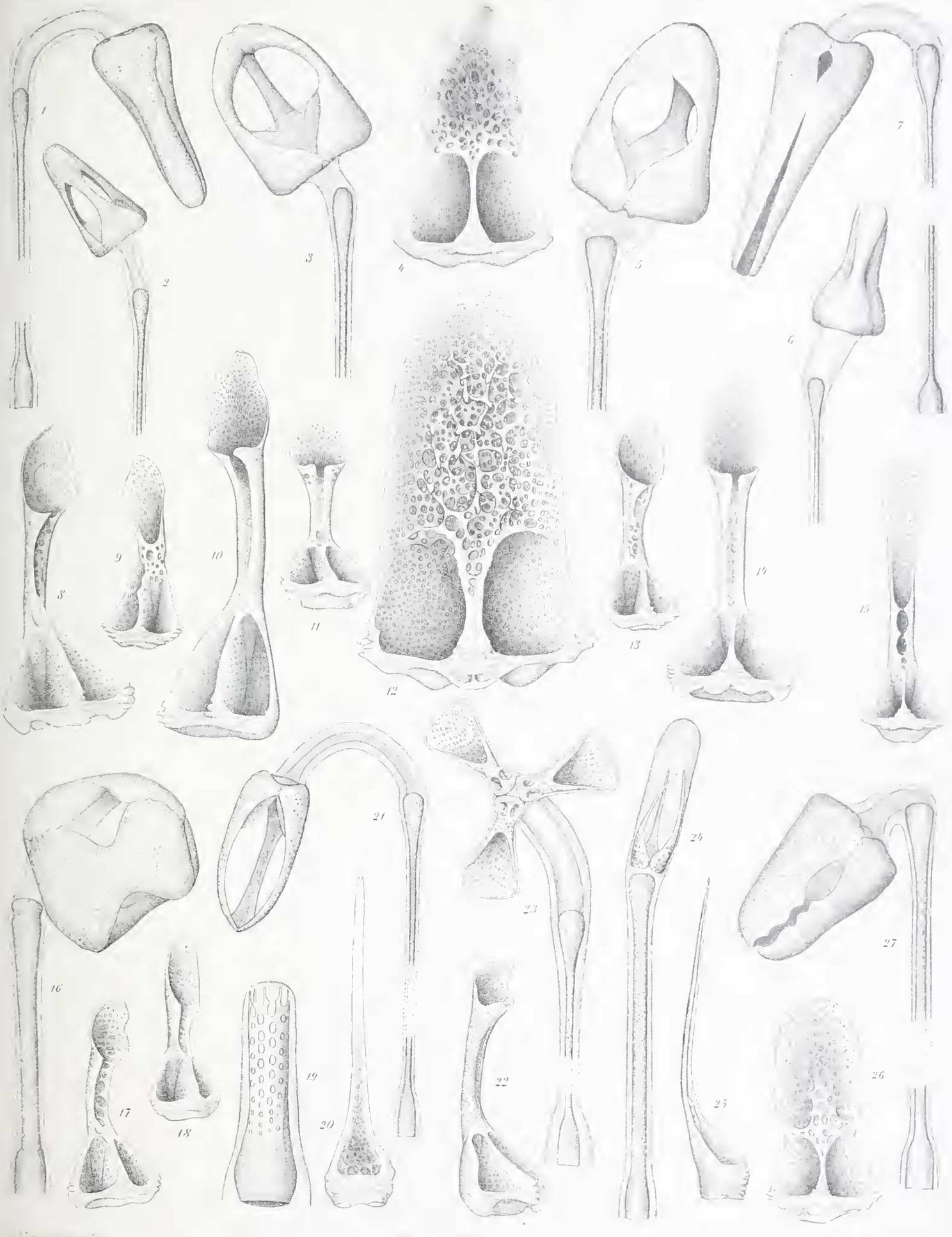
Fig. 1. Valve of tridentate pedicellaria of *Phormosoma bursarium*. Obj. II. Oc. I.
— 2. — - — — - — *placenta*, from the Davis Strait. Obj. II. Oc. 0.
— 3. — - — — - — — — the Gulf of Mexico. Obj. II. Oc. 0.
— 4. Developmental stage of a large tridentate pedicellaria of *Phormosoma placenta*. Obj. II. Oc. 0.
— 5. Valve of a half developed — — — - — — Obj. II. Oc. 0.
— 6. — — tridentate pedicellaria of *Phormosoma rigidum*. Obj. II. Oc. I.
— 7. — — — — - — *placenta* (Ingolf. St. 40). Obj. II. Oc. 0.
— 8—10. Transverse sections of the head of a globiferous pedicellaria of *Hapalosoma pellucidum* 8. nearest to the basis, 10. in the middle, 9. at the point. Obj. II. Oc. III.
— 11. Actinal primary spine of *Phormosoma placenta*, the bag of skin removed. Obj. 00. Oc. 0.
— 12. Valve of a triphyllous pedicellaria of *Kamptosoma asterias*. Obj. II. Oc. III.
— 13. — — — — - «*Asthenos. gracile* (Chall. St. 219). Obj II. Oc. III.
— 14. — — — — - *Hapalosoma pellucidum*. Obj. II. Oc. III.
— 15. Developmental stage of a triphyllous pedicellaria of *Phormosoma placenta*. Obj. II. Oc. I.
— 16. Valve of a triphyllous pedicellaria of *Aperosoma Grimaldii*. Obj. II. Oc. I.
— 17. — — — — - *Echinosoma uranus*. Obj. II. Oc. I.
— 18. — — — — - *Asthenosoma varium*. Obj. II. Oc. III.
— 19. Spine from the peristome of *Phormosoma placenta*; with bag of skin. Obj. 0. Oc. 0.
— 20. Valve of a triphyllous pedicellaria of *Hygrosoma luculentum*. Obj. II. Oc. I.
— 21. — — — — - *Phormosoma placenta*. Obj II. Oc. I.
— 22. — — tridentate — small form, of *Tromikosoma Koehleri*. Obj. II. Oc. 0.
— 23. Sphæridia of *Phormosoma placenta*. Obj. II. Oc. I.
— 24. Developmental stage of a triphyllous pedicellaria of *Phormosoma placenta*. Obj. II. Oc. I.
— 25. Sphæridia of *Phormosoma placenta*. Obj. II. Oc. I.
— 26. Valve of a small tridentate pedicellaria of *Phormosoma placenta*. Obj. II. Oc. 0.
— 27. — — triphyllous pedicellaria of *Aræosoma coriaceum*. Obj. II. Oc. I.
— 28. — — — — - *Phormosoma bursarium*. Obj. II. Oc. I.
— 29. — — — — - *Aræosoma Belli*. Obj. II. Oc. I.
— 30. Developmental stage of a triphyllous pedicellaria of *Phormosoma placenta*. Obj. II. Oc. I.
— 31. Valve of a triphyllous pedicellaria of *Tromikosoma Koehleri*. Obj. II. Oc. I.
— 32. — — — — - *Kamptosoma asterias* («*Phormosoma tenue*», Chall. St. 272). Obj. II. Oc. III.
— 33. Valve of a triphyllous — - *Aræosoma fenestratum*. Obj. II. Oc. I.
— 34. — — — — - *Calveria hystrix*. Obj. II. Oc. III.
— 35. — — large tridentate pedicellaria of *Echinosoma tenue*, seen half from the side. Obj. 0. Oc. 0.
— 36. — — tridentate — - — *uranus*. Obj. II. Oc. I.
— 37 and 39. Valve of a small tridentate pedicellaria of *Phormosoma placenta*. Obj. II. Oc. 0. The edge finely serrate, which cannot be seen under the magnifying powers used in the drawing.
— 38. Valve of a half developed triphyllous pedicellaria of *Phormosoma placenta*. Obj. II. Oc. I.
— 40. — — small tridentate pedicellaria of *Echinosoma tenue*. Obj. II. Oc. 0.
— 41. — — large — - *Tromikosoma Koehleri*. Obj. 0. Oc. 0.
— 42. — — triphyllous pedicellaria of *Hygrosoma Petersii*. Obj. II. Oc. I.



Echinothuridae.

Plate XIII.

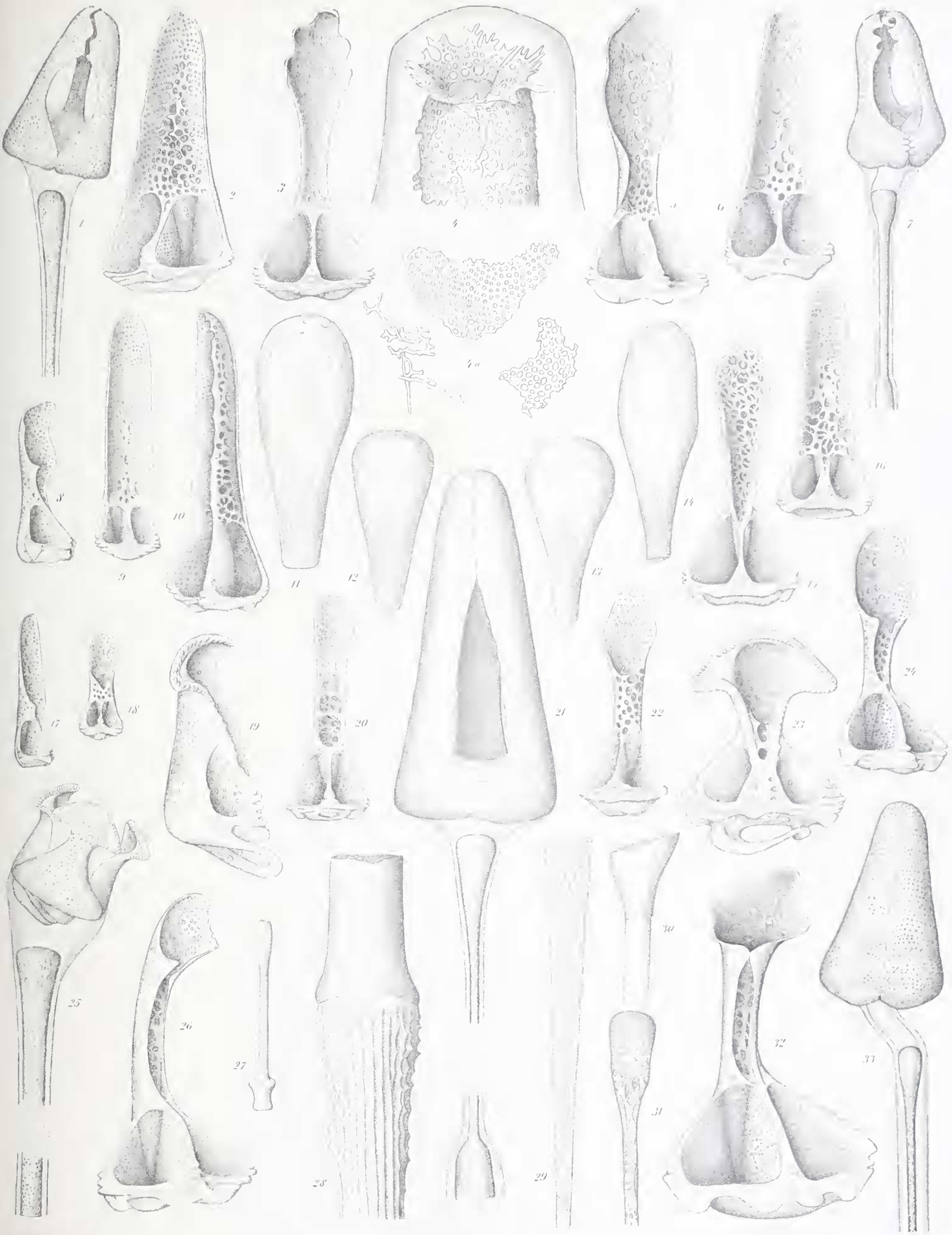
Fig. 1. Tridentate pedicellaria, small form, of *Asthenosoma varium*. Obj. o. Oc. I.
— 2. — — — — - *Hygrosoma luculentum*. Obj. o. Oc. o.
— 3. — — large — - *Calveria gracilis*. Obj. o. Oc. I.
— 4. Valve of a tridentate pedicellaria, short form, of *Asthenosoma varium*. Obj. o. Oc. I.
— 5. Tridentate pedicellaria, large form, of *Arœosoma tesselatum*. Obj. o. Oc. o.
— 6. — — small — - — — Obj. o. Oc. o.
— 7. — — long, narrow form of *Phormosoma placenta* (Ingolf. St. 40). Obj. o. Oc. o.
— 8. Valve of a large tridentate pedicellaria of *Hygrosoma Petersii*. Obj. II. Oc I.
— 9. — — — — — - *Kamptosoma asterias*. Obj. II. Oc. I.
— 10. — — — — — - *Arœosoma Belli*. Obj. o. Oc. I. The basal part was broken, is partly constructed, may be not quite correctly.
— 11. Valve of a small tridentate pedicellaria of *Arœosoma Belli*. Obj. II. Oc. I.
— 12. — — large — — - *Sperosoma Grimaldii*. Obj. o. Oc. I.
— 13. — — small — — - *Hygrosoma Petersii*. Obj. II. Oc. I.
— 14. — — large — — - — *luculentum*. Obj. II. Oc. I.
— 15. — — — — — - *Kamptosoma asterias* («*Phormos. tenue*». Chall. St. 272). Obj. II. Oc. I.
— 16. Tridentate pedicellaria, short form, of *Hygrosoma luculentum*. Obj. oo. Oc. I.
— 17—18. Valves of tridentate pedicellariæ of *Calveria hystrix*. Obj. II. Oc. o.
— 19. Developmental stage of a spine of *Phormosoma placenta*. Obj. II. Oc. I.
— 20. Valve of a globiferous pedicellaria of *Hapalosoma pellucidum*, from the inside. Obj. II. Oc. I.
— 21. Tridentate pedicellaria, larger form, of *Kamptosoma asterias* («*Phormos. tenue*». Chall. St. 272). Obj. o. Oc. I.
— 22. Valve of tridentate pedicellaria af *Arœosoma Belli*. Obj. II. Oc. o.
— 23. Triphyllous pedicellaria of *Sperosoma Grimaldii*. Obj. o. Oc. I.
— 24. Globiferous pedicellaria of *Hapalosoma pellucidum*. Obj. o. Oc. o.
— 25. Valve of globiferous pedicellaria of *Hapalosoma pellucidum*, from the side. Obj. II. Oc. I.
— 26. — - tridentate — - *Asthenosoma gracile* (Chall. St. 184). Obj. II. Oc. I.
— 27. Tridentate pedicellaria, short form, of *Asthenosoma Grubei*. Obj. o. Oc. o.



Echinothuridae

Plate XIV.

Fig. 1. Tridentate pedicellaria, smaller form, of *Arœosoma fenestratum*. Obj. 0. Oc. 0.
— 2. Valve of a larger tridentate pedicellaria of *Sperosoma Grimaldii*. Obj. 0. Oc. I.
— 3. — — large — — - *Asthenosoma varium*. Obj. 0. Oc. 0.
— 4. The point of an actinal tube foot of *Sperosoma Grimaldii*. Obj. II. Oc. I.
— 4. a. Spicules of tube feet of *Sperosoma Grimaldii*; the two large ones from an actinal tube foot, the small ones from an abactinal tube foot. Obj. II. Oc. I.
— 5. Valve of a large tridentate pedicellaria of *Arœosoma coriaceum*. Obj. 0. Oc. 0.
— 6. — — smaller — — - *Sperosoma Grimaldii*. Obj. II. Oc. I.
— 7. Tridentate pedicellaria, large form, of *Asthenosoma Grubei*. Obj. 00. Oc. 0.
— 8. Valve of a tridentate pedicellaria, smaller form, of *Arœosoma fenestratum*. Obj. II. Oc. 0.
— 9. — — — — — — - *Hapalosoma pellucidum*; the edge finely serrate. Obj. II. Oc. 0.
— 10. Valve of a tridentate pedicellaria, small — - *Asthenosoma varium*. Obj. II. Oc. 0.
— 11. Sphæridia of *Sperosoma Grimaldii*. Obj. II. Oc. I.
— 12. — - *Tromikosoma Koehleri*. Obj. II. Oc. 0.
— 13. — - *Calveria hystrix*. Obj. II. Oc. I.
— 14. — - *Arœosoma fenestratum*. Obj. II. Oc. I.
— 15. Valve of a tridentate pedicellaria of *Arœosoma tesselatum*. Obj. II. Oc. 0.
— 16. — — — — - *Tromikosoma Koehleri*, small form. Obj. II. Oc. 0.
— 17—18. Valves of tridentate pedicellariæ of *Arœosoma fenestratum*, small forms. Obj. II. Oc. 0.
— 19. Valve of an ophicephalous pedicellaria of *Tromikosoma Koehleri*, from the side. Obj. II. Oc. I.
— 20. — - a tridentate — - «*Asthenosoma gracile*», Chall. St. 219. Obj. II. Oc. I.
— 21. Tridentate pedicellaria, large form, of *Tromikosoma Koehleri*. Obj. 0. Oc. 0.
— 22. Valve of a tridentate pedicellaria, smaller form, of *Kamptosoma asterias* («*Phormosoma tenue*», Chall. St. 272). Obj. II. Oc. I.
— 23. Valve of an ophicephalous pedicellaria of *Tromikosoma Koehleri*, from the inside. Obj. II. Oc. I.
— 24. — - a tridentate — - *Arœosoma fenestratum*, smaller form. Obj. II. Oc. 0.
— 25. Ophicephalous pedicellaria of *Tromikosoma Koehleri*. Obj. 0. Oc. I.
— 26. Valve of a large tridentate pedicellaria of *Calveria hystrix*. Obj. II. Oc. 0.
— 27. Spine with a parasitic Copepod, of *Calveria gracilis*. $^4/_1$.
— 28. The point of a spine from the peristome of *Tromikosoma Koehleri*. Obj. 0. Oc. 0.
— 29. Piece of a spine of *Kamptosoma asterias*. Obj. 0. Oc. 0.
— 30. The point of a primary actinal spine of *Tromikosoma Koehleri*. $^4/_1$.
— 31. Outer end of the stalk of a triphyllous pedicellaria of *Sperosoma Grimaldii*. Obj. II. Oc. I.
— 32. Valve of a large tridentate pedicellaria of *Arœosoma fenestratum*. Obj. II. Oc. 0.
— 33. Tridentate pedicellaria of *Sperosoma Grimaldii*. Obj. 0. Oc. 0.



Echinothuridæ.

Plate XV.

Fig. 1. Ambulacral area of *Echinus esculentus.* $^{1}/_{1}$.

— 2. Interambulacral area of *Echinus acutus*, var. *norvegicus.* $^{2}/_{1}$.

— 3. — — - — *affinis.* $^{2}/_{1}$.

— 4. — — - — *elegans.* $^{2}/_{1}$.

— 5. — — - — *esculentus.* $^{1}/_{1}$.

— 6. Apical area of *Parechinus miliaris.* $^{2}/_{1}$.

— 7. Ambulacral area of *Parechinus miliaris.* $^{2}/_{1}$.

— 8. — — - — *microtuberculatus.* $^{2}/_{1}$.

— 9. Interambulacral area of *Parechinus microtuberculatus.* $^{2}/_{1}$.

— 10. Ambulacral area of *Echinus affinis.* $^{2}/_{1}$ (young specimen).

— 11. Interambulacral area of *Parechinus miliaris.* $^{2}/_{1}$.

— 12. Apical area of *Parechinus microtuberculatus.* $^{2}/_{1}$.

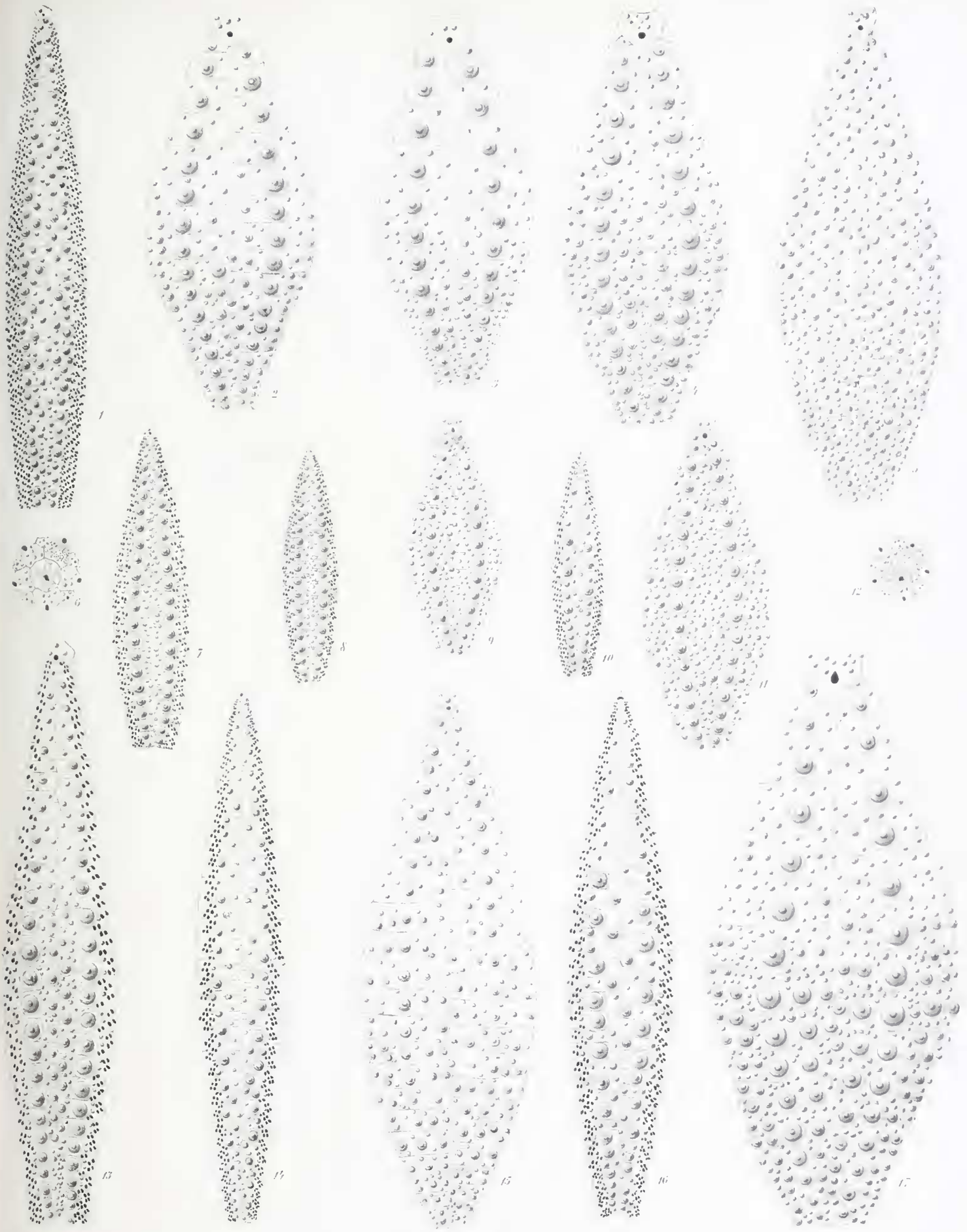
— 13. Ambulacral area of *Echinus Alexandri.* $^{2}/_{1}$.

— 14. — — - — *acutus*, var. *mediterranea.* $^{1}/_{1}$.

— 15. Interambulacral area of *Echinus acutus*, var. *mediterranea.* $^{1}/_{1}$.

— 16. Ambulacral area of *Echinus acutus*, var. *norvegicus.* $^{2}/_{1}$.

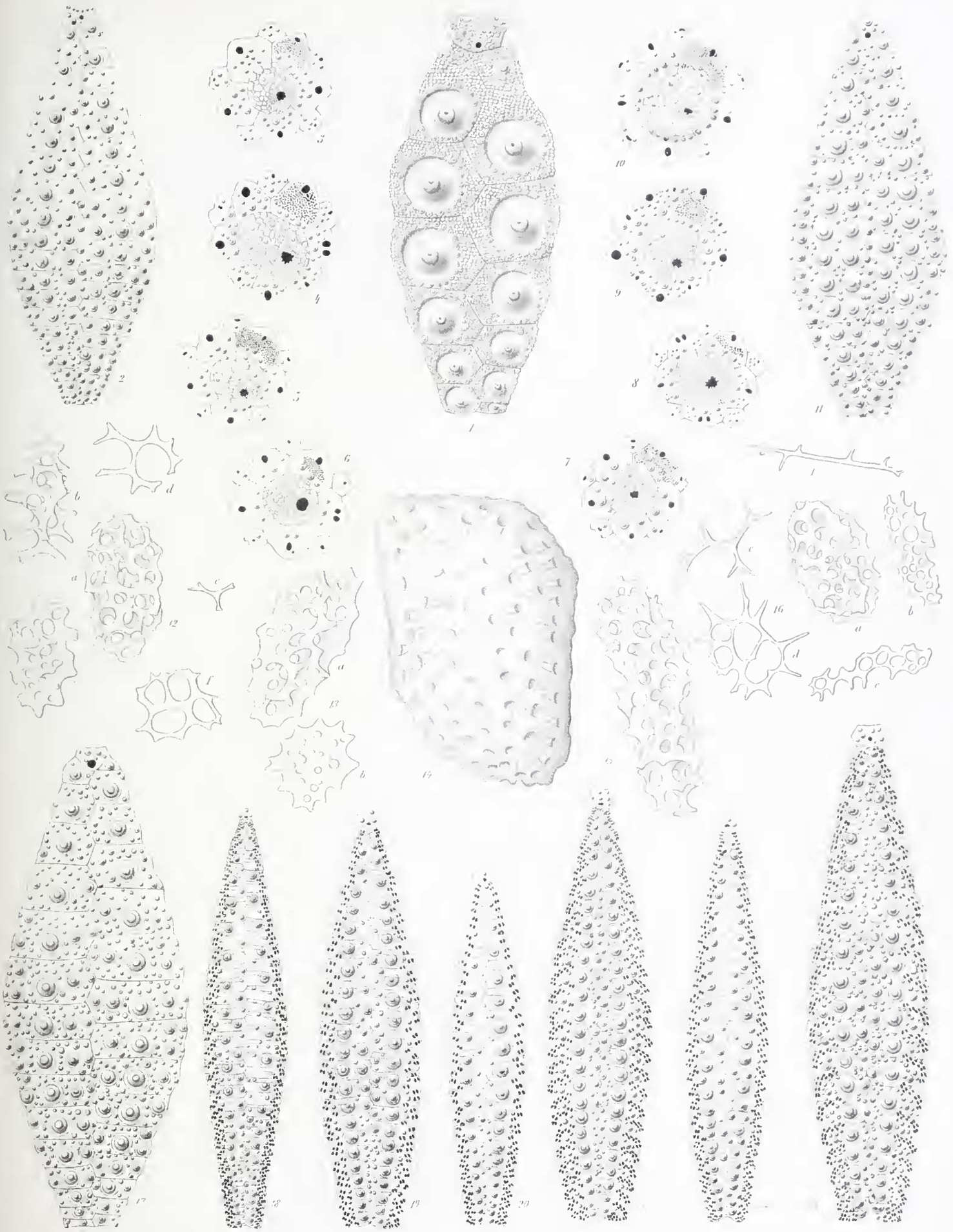
— 17. Interambulacral area of *Echinus Alexandri.* $^{2}/_{1}$.



Echinus, Parechinus

Plate XVI.

Fig. 1. Interambulacral area of *Stereocidaris ingolfiana*. $^{2}/_{1}$.
— 2. — — - *Echinus acutus*, var. *Flemingii*. $^{1}/_{1}$.
— 3. Apical area of *Echinus elegans*. $^{2}/_{1}$.
— 4. — — - *Strongylocentrotus drøbachiensis*. $^{2}/_{1}$.
— 5. — — - *Echinus acutus*, var. *norvegicus*. $^{2}/_{1}$.
— 6. — — - — *affinis*. $^{2}/_{1}$. With two pores in one of the genital plates.
— 7. — — - — *esculentus*. $^{2}/_{1}$.
— 8. — — - — *Alexandri*. $^{2}/_{1}$. With two pores in two of the genital plates.
— 9. — — - *Strongylocentrotus drøbachiensis*. $^{2}/_{1}$.
— 10. — — - *Echinus acutus*, var. *Flemingii*. $^{2}/_{1}$.
— 11. Interambulacral area of *Strongylocentrotus drøbachiensis*, f. *granularis*. $^{2}/_{1}$.
— 12. Plates from the buccal membrane and the gills of *Echinus esculentus*. a. b. from the buccal membrane outside the buccal plates, c. from inside the buccal plates, d. e. f. from the gills. Obj. II. Oc. III.
— 13. Plates from the buccal membrane of *Strongylocentrotus drøbachiensis*. a. outside, b. inside the buccal plates. Obj. II. Oc. III.
— 14. Plate from the buccal membrane of *Parechinus microtuberculatus*. Obj. II. Oc. III.
— 15. — — — — - — *miliaris*. Obj. II. Oc. III.
— 16. Plates from the buccal membrane and the gills of *Echinus acutus*, var. *Flemingii*. a. b. from the buccal membrane outside the buccal plates, c. from inside the buccal plates, d. e. f. from the gills. a. b. Obj. II. Oc. I., c.—f. Obj. II. Oc. III.
— 17. Interambulacral area of *Strongylocentrotus drobachiensis*, f. *pallidus*. $^{2}/_{1}$.
— 18. Ambulacral area of *Echinus acutus*, var. *Flemingii*. $^{1}/_{1}$.
— 19. — — - — *elegans*. $^{2}/_{1}$.
— 20. — — - — *affinis*. $^{2}/_{1}$.
— 21. — — - *Strongylocentrotus drøbachiensis*, f. *granularis*. $^{2}/_{1}$.
— 22. — — - *Echinus acutus*, var. *norvegicus*. $^{2}/_{1}$.
— 23. — — - *Strongylocentrotus drøbachiensis*, f. *pallidus*. $^{2}/_{1}$.



Stereocidaris, Parechinus, Echinus, Strongylocentrotus

Plate XVII.

Fig. 1. Valve of a globiferous pedicellaria of *Parechinus miliaris*, from the side. Obj. V. Oc. o.

2. — — tridentate — from the buccal membrane of *Parechinus miliaris*. Obj. II. Oc. III.

— 3. — — ophicephalous — of *Parechinus angulosus*. Obj. II. Oc. I.

— 4. — — triphyllous — - *Stomopneustes variolaris*. Obj. D. Oc. III. (Zeiss.)

— 5. — — globiferous — - *Loxechinus albus*. Obj. II. Oc. I.

— 6. — — tridentate — large form, of *Parechinus angulosus*. Obj. II. Oc. o.

— 7. — — globiferous — from the inside, of *Parechinus miliaris*. Obj. V. Oc. o.

— 8. — — ophicephalous — of *Parechinus miliaris*. Obj. II. Oc. I.

— 9. — — tridentate — small form, of *Parechinus angulosus*. Obj. II. Oc. I.

— 10. Spicules of *Parechinus miliaris*. Obj. V. Oc. I.

— 11. Valve of a tridentate pedicellaria of *Parechinus miliaris*. Obj. II. Oc. III.

— 12. — — — — - *Loxechinus gibbosus*. Obj. II. Oc. I.

— 13. Spicules from the gills of *Stomopneustes variolaris*. Obj. D. Oc. I. (Zeiss.)

— 14. Valve of a triphyllous pedicellaria of *Parechinus miliaris*. Obj. V. Oc. o.

— 15. End-tooth of a globiferous pedicellaria of *Parechinus miliaris*. Obj. V. Oc. III.

— 16. Valve of a tridentate pedicellaria of *Stomopneustes variolaris*. Obj. D. Oc. II. (Zeiss.)

— 17. — — globiferous — - — — Obj. D. Oc. I. (Zeiss.)

— 18. — — tridentate — - *Loxechinus albus*. Obj. II. Oc. o.

— 19. — — globiferous — - *Paracentrotus lividus*. Obj. II. Oc. I.

— 20. — — tridentate — - *Stomopneustes variolaris*; from the inside. Obj. D. Oc. II. (Zeiss.)

— 21. — — — — - *Paracentrotus lividus*. Obj. o. Oc. I.

— 22. Tridentate pedicellaria of *Parechinus miliaris*. Obj. II. Oc. I.

— 23. Globiferous — - — — open. Obj. II. Oc. I.

— 24. — — - — — shut. Obj. II. Oc. I.

— 25. Triphyllous — - — — Obj. II. Oc. I.

— 26–27. Sphæridiæ of *Parechinus miliaris*. Obj. II. Oc. III.

— 28. Ophicephalous pedicellaria of *Parechinus miliaris*. Obj. II. Oc. I.

Parechinus, Loxechinus, Paracentrotus, Stomopneustes.

Plate XVIII.

Fig. 1. Valve of a tridentate pedicellaria of *Echinus acutus*, var. *norvegicus*, from the side. Obj. II. Oc. I.
— 2. — — globiferous — - — *elegans*, from the inside. Obj. II. Oc. I.
— 3. — — — — - — — - - side. Obj. II. Oc. I.
— 4. Tridentate pedicellaria of *Echinus affinis*. Obj. o. Oc. o.
— 5. — — - — *acutus*. Obj. o. Oc. o.
— 6. Valve of a globiferous pedicellaria of *Echinus acutus*, from the side. Obj. II. Oc. I.
— 7. — — tridentate — - — — var. *norvegicus*, from the inside. Obj. II. Oc. I.
— 8. Spicules of *Echinus melo*. Obj. V. Oc. I.
— 9. Valve of a globiferous pedicellaria of *Echinus Alexandri* (The type-specimen). Obj. II. Oc. o.
— 10. — — — — - — *gracilis*. Obj. II. Oc. I.
— 11. — — — — - — *Alexandri*. Obj. II. Oc. I.
— 12. Spicules of *Echinus esculentus*. Obj. V. Oc. I.
— 13. Valve of a tridentate pedicellaria, small form, of *Echinus esculentus*. Obj. II. Oc. o.
— 14. Spicules of *Echinus acutus*, var. *Flemingii*. Obj. V. Oc. I.
— 15. Valve of a tridentate pedicellaria, small form, of *Echinus gracilis*. Obj. II. Oc. I.
— 16. — — globiferous — of *Echinus affinis*. Obj. II. Oc. I.
— 17. — — — — - — *atlanticus*. Obj. II. Oc. o.
— 18. — — — — - — *melo*. Obj. II. Oc. o.
— 19. — — triphyllous — - — *Alexandri* (type-specimen). Obj. II. Oc. I.
— 20. — — tridentate — - — *esculentus*. Obj. II. Oc. o.
— 21. — — — — - — *gracilis*, large form. Obj. II. Oc. o.
— 22. — — — — - — *elegans*, from the inside. Obj. II. Oc. o.
— 23. — — — — - — *Alexandri*, from the inside. Obj. o. Oc. I.
— 24. Globiferous pedicellaria of *Echinus acutus*, var. *norvegicus*. Obj. o. Oc. I.
— 25. Valve of a tridentate pedicellaria of *Echinus Alexandri*, from the side. Obj. II. Oc. I.
— 26. — — — — - — *elegans*, from the side. Obj. II. Oc. I.
— 27. — — — — - — *lucidus*. Obj. II. Oc. I.
— 28. — — — — - — *affinis*. Obj. o. Oc. I.

Echinus

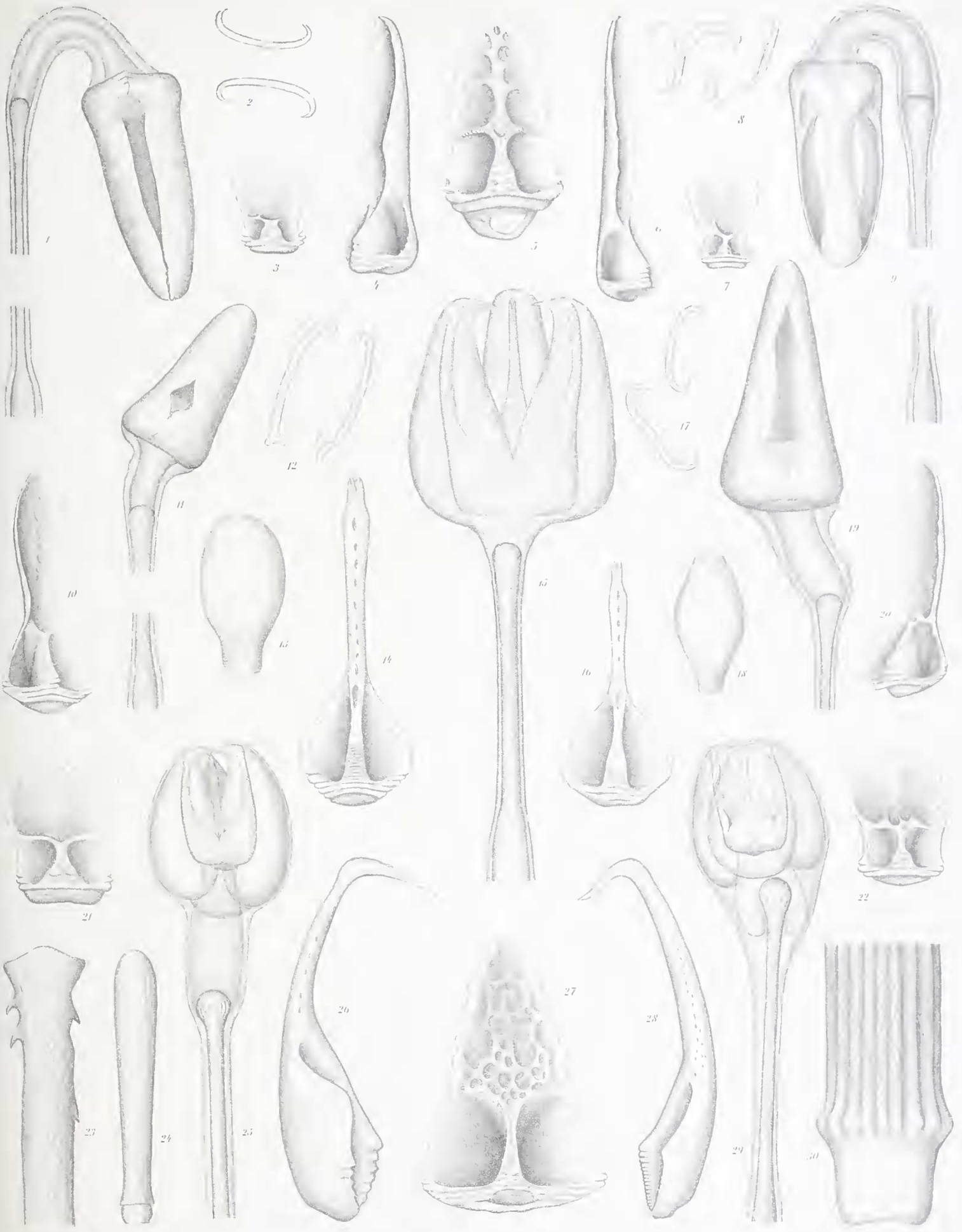
Plate XIX.

Fig. 1. Valve of a tridentate pedicellaria of *Colobocentrotus atratus*. Obj. II. Oc. I.
— 2. — — — — - *Sterechinus horridus*. Obj. II. Oc. I.
— 3. — — — — - — *margaritaceus*. Obj. II. Oc. o.
— 4. — — globiferous — - *Toxocidaris tuberculatus*, from the side. Obj. II. Oc. I.
— 5. — — — — - *Colobocentrotus atratus*. Obj. AA. Oc. III. (Zeiss.)
— 6. — — — — - *Heliocidaris chloroticus*, from the side. Obj. II. Oc. I.
— 7. — — tridentate — - — *rarituberculatus*. Obj. II. Oc. I.
— 8. — — — — - *Toxocidaris tuberculatus*. Obj. o. Oc. I.
— 9. — — — — - — — broad form. Obj. II. Oc. I.
— 10. — — ophicephalous — - *Echinus elegans*. Obj. II. Oc. I.
— 11. — — tridentate — - *Sterechinus magellanicus*, from the inside. Obj. II. Oc. III.
— 12. — — globiferous — - *Heliocidaris chloroticus*, from the inside. Obj. II. Oc. I.
— 13. — — — — - *Toxocidaris tuberculatus*, from the inside. Obj. II. Oc. I.
— 14. — — — — - *Sterechinus Neumayeri*. Obj. II. Oc. I.
— 15. — — tridentate — - *Heterocentrotus mamillatus*. Obj. AA. Oc. III. (Zeiss.)
— 16. — — ophicephalous — - *Echinus Alexandri*. Obj. II. Oc. III.
— 17. — — tridentate — - *Sterechinus magellanicus*, from the side. Obj. II. Oc. III.
— 18. — — globiferous — - *Echinus lucidus*. Obj. II. Oc. I.
— 19. — — — — - *Pseudechinus albocinctus*. Obj. II. Oc. I.
— 20. — — — — - *Sterechinus margaritaceus*. Obj. II. Oc. I.
— 21. — — tridentate — - *Echinometra van Brunti*. Obj. AA. Oc. I. (Zeiss.)
— 22. — — globiferous — - *Sterechinus horridus*. Obj. II. Oc. I.
— 23. — — — — - — *magellanicus*. Obj. II. Oc. I.
— 24. — — — — - *Echinus esculentus*. Obj. II. Oc. I.
— 25. — — tridentate — - *Pseudechinus albocinctus*. Obj. II. Oc. I.
— 26. Sphæridia of *Echinus elegans*. Obj. II. Oc. III.
— 27. — - — *affinis*. Obj. II. Oc. III.
— 28. — - — *esculentus*. Obj. II. Oc. III.
— 29. Valve of a triphyllous pedicellaria of *Heliocidaris chloroticus*. Obj. II. Oc. III.
— 30. Sphæridia of *Echinus esculentus*. Obj. II. Oc. III.
— 31. — - — *Alexandri*. Obj. II. Oc. III.
— 32. — - — *acutus*, var. *Flemingii*. Obj. II. Oc. III.
— 33. Valve of a tridentate pedicellaria of *Sterechinus margaritaceus*. Obj. II. Oc. o.
— 34. — — — — - *Echinus Alexandri* (Type-specimen). Obj. II. Oc. o.
— 35. — — — — - *Heterocentrotus trigonarius*. Obj. AA. Oc. II. (Zeiss.)
— 36. Two valves of an ophicephalous pedicellaria, in connection, of *Echinus acutus*. Obj. II. Oc. I.
— 37. Valve of an ophicephalous pedicellaria of *Echinus atlanticus*. Obj. II. Oc. o.
— 38. — — tridentate — - — *Alexandri*, very small form (of a small specimen). Obj. II. Oc. III.
— 39. Valve of a tridentate pedicellaria of *Heliocidaris chloroticus*. Obj. II. Oc. I.

Echinidae, Echinometridae.

Plate XX.

Fig. 1. Tridentate pedicellaria of *Echinus Alexandri*. Obj. o. Oc. I.
— 2. Spicules of *Echinus Alexandri*. Obj. V. Oc. I.
— 3. Valve of a triphyllous pedicellaria of *Strongylocentrotus drøbachiensis*. Obj. II. Oc. III.
— 4. — — tridentate — - — — f. *granulatus*. Obj. o. Oc. I.
— 5. — — ophicephalous — - — — Obj. II. Oc. III.
— 6. — — tridentate — - — — Obj. o. Oc. I.
— 7. — — triphyllous — - *Sterechinus Neumayeri*. Obj. II. Oc. III.
— 8. Spicules of *Echinus elegans*. Obj. V. Oc. I.
— 9. Tridentate pedicellaria, small form, of *Echinus elegans*. Obj. II. Oc. o.
— 10. Valve of a tridentate pedicellaria of *Strongylocentrotus pulcherrimus*. Obj. II. Oc. o.
— 11. Tridentate pedicellaria of *Sterechinus Neumayeri*. Obj. o. Oc. I.
— 12. Spicules of *Strongylocentrotus drøbachiensis*. Obj. V. Oc. I.
— 13. Sphæridia of — Obj. II. Oc. III.
— 14. Valve of a globiferous pedicellaria of *Strongylocentrotus purpuratus*, from the inside. Obj. II. Oc. o.
— 15. Globiferous pedicellaria of *Psammechinus variegatus*. Obj. II. Oc. o. The skin full of spicules.
— 16. Valve of a globiferous pedicellaria of *Strongylocentrotus drøbachiensis*, from the inside. Obj. II. Oc. I.
— 17. Spicules of *Echinus affinis*. Obj. V. Oc. I.
— 18. Sphæridia of *Strongylocentrotus drøbachiensis*. Obj. II. Oc. III.
— 19. Tridentate pedicellaria, large form, of *Echinus elegans*. Obj. o. Oc. o.
— 20. Valve of a tridentate pedicellaria of *Strongylocentrotus drøbachiensis*. Obj. o. Oc. I.
— 21. — — triphyllous - - *Echinus affinis*. Obj. II. Oc. III.
— 22. — — — — - — *elegans*. Obj. II. Oc. III.
— 23. Stalk of a globiferous pedicellaria of *Echinus elegans*. Obj. II. Oc. I.
— 24. Spine from the buccal plates of *Echinus esculentus*. Obj. o. Oc. o.
— 25. Globiferous pedicellaria, the neck protruded, of *Strongylocentrotus drøbachiensis*. The spicules are drawn only on the upper side of the head. Obj. o. Oc. I.
— 26. Valve of a globiferous pedicellaria of *Strongylocentrotus drøbachiensis*, from the side. Obj. II. Oc. I.
— 27. — — ophicephalous — large form, of *Echinus Alexandri*. Obj. II. Oc. o.
— 28. — — globiferous — of *Strongylocentrotus purpuratus*, from the side. Obj. II. Oc. o.
— 29. Globiferous pedicellaria, the neck retracted, of *Strongyloc. drøbachiensis*. Obj. o. Oc. III.
— 30. Spine of *Echinus esculentus*, the basal part. Obj. o. Oc. o.



Echinus. Sterechinus. Psammechinus. Strongylocentrotus

Plate XXI.

Fig. 1. Valve of a tridentate pedicellaria of *Pseudoboletia maculata*. Obj. o. Oc. I.
— 2. — — — — - *Psammechinus verruculatus*. Obj. II. Oc. I.
— 3. — — — — - *Tripneustes esculentus*. Obj. II. Oc. o.
— 4. — — — — - *Gymnechinus Robillardi*, from the side. Obj. II. Oc. I.
— 5. — — ophicephalous — - *Pseudoboletia maculata*. Obj. II. Oc. I.
— 6. — — tridentate — - *Anthocidaris homalostoma*. Obj. II. Oc. o.
— 7. — — — — - *Gymnechinus darnleyensis*. Obj II. Oc. I.
— 8. — — — — - *Pseudocentrotus depressus*. Obj. o. Oc. o.
— 9. — — — — - — — Obj. II. Oc. o.
— 10. — — — — - *Psammechinus variegatus*. Obj. II. Oc. o.
— 11. — — — — - *Gymnechinus Robillardi*, from the inside. Obj. II. Oc. I.
— 12. Spicules of *Sphærechinus granularis*. Obj. V. Oc. III.
— 13. Valve of a globiferous pedicellaria of *Toxopneustes pileolus*. Obj. II. Oc. o.
— 14. Spicules of *Pseudocentrotus depressus*; a. from the tube feet, b. from the pedicellariæ. Obj. V. Oc. o.
— 15. Valve of a tridentate pedicellaria of *Pseudocentrotus depressus*. Obj. II. Oc. o.
— 16. — — — — - *Tripneustes esculentus*. Obj. II. Oc. o.
— 17. — — — — - *Pseudoboletia maculata*, small form. Obj. o. Oc. I.
— 18. Plates from the buccal membrane and the gills of *Echinus Alexandri*; a. from the buccal membrane inside of the buccal plates, b. c. from the gills. Obj. II. Oc. I.
— 19. Piece of the stalk of a pedicellaria of *Echinus Alexandri*. Obj. V. Oc. I.
— 20. — — edge of a tridentate pedicellaria of *Ech. Alexandri*. Obj. V. Oc. III.
— 21. Spicules of *Toxopneustes pileolus*; a. from globiferous pedicellariæ, b. from tube feet, c. from the buccal membrane. Obj. V. Oc. I.
— 22. Valve of an ophicephalous pedicellaria of *Tripneustes esculentus*. Obj. II. Oc. I.
— 23. Spicules from pedicellariæ of *Gymnechinus darnleyensis*. Obj. V. Oc. III.
— 24. — - *Gymnechinus Robillardi*; a. from pedicellariæ, Obj. V. Oc. I, b. from the buccal membrane. Obj. II. Oc. I.
— 25. Piece of the edge of a tridentate pedicellaria of *Echinus acutus*, var. *Flemingii*. Obj. V. Oc. III.
— 26. — — stalk of a pedicellaria of *Echinus acutus*, var. *Flemingii*. Obj. V. Oc. I.
— 27. Plate from the buccal membrane, outside of the buccal plates, of *Echinus Alexandri*. Obj. II. Oc. I.
— 28. Spicules from pedicellariæ of *Psammechinus verruculatus*. Obj. V. Oc. III.
— 29. — - — - *Pseudoboletia maculata*. Obj. V. Oc. I.
— 30. — - tube feet of *Anthocidaris homalostoma*. Obj. V. Oc. o.
— 31. — - globiferous pedicellaria of *Psammechinus variegatus*; a developmental series. Obj. V. Oc. III.
— 32. — - tube feet of *Parasalenia gratiosa*. Obj. V. Oc. I.
— 33. — of *Tripneustes esculentus*; a. from globiferous pedicellariæ, b. from tube feet, c. d. from the buccal membrane. Obj. V. Oc. I.
— 34. Valve of a tridentate pedicellaria of *Sphærechinus granularis*. Obj. o. Oc. I.
— 35. — globiferous — - — — from the side. Obj. II. Oc. o.
— 36. — — — — - *Gymnechinus darnleyensis*. Obj. II. Oc. III.
— 37. — — — — - *Sphærechinus granularis*, from the inside. Obj. II. Oc. o.
— 38. — — — — - *Psammechinus variegatus*, - - — Obj. II. Oc. I.
— 39. — — — — - *Tripneustes esculentus*. Obj. II. Oc. I.
— 40. — — — — - *Psammechinus variegatus*, from the side. Obj. II. Oc. I.
— 41. — — tridentate — - *Toxopneustes pileolus*. Obj o. Oc. o.

Echinidae, Toxopneustidae

THE INGOLF-EXPEDITION

1895—1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS.

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
1	62° 30′	8° 21′	132	7°2	24	63° 06′	56° 00′	1199	2°4	45	61° 32′	9° 43′	643	4°17
2	63° 04′	9° 22′	262	5°3	25	63° 30′	54° 25′	582	3°3	46	61° 32′	11° 36′	720	2°40
3	63° 35′	10° 24′	272	0°5		63° 51′	53° 03′	136		47	61° 32′	13° 40′	950	3°23
4	64° 07′	11° 12′	237	2°5	26	63° 57′	52° 41′	34	0°6	48	61° 32′	15° 11′	1150	3°17
5	64° 40′	12° 09′	155			64° 37′	54° 24′	109		49	62° 07′	15° 07′	1120	2°91
6	63° 43′	14° 34	90	7°0	27	64° 54′	55° 10′	393	3°8	50	62° 43′	15° 07′	1020	3°13
7	63° 13′	15° 41′	600	4°5	28	65° 14′	55° 42′	420	305	51	64° 15′	14° 22′	68	7°32
8	63° 56′	24° 40′	136	6°0	29	65° 34′	54° 31′	68	0°2	52	63° 57′	13° 32′	420	7°87
9	64° 18′	27° 00′	295	5°8	30	66° 50′	54° 28′	22	1°05	53	63° 15′	15° 07′	795	3°08
10	64° 24′	28° 50′	788	3°5	31	66° 35′	55° 54′	88	1°6	54	63° 08′	15° 40′	691	3°9
11	64° 34′	31° 12′	1300	1°6	32	66° 35′	56° 38′	318	3°9	55	63° 33′	15° 02′	316	5°9
12	64° 38′	32° 37′	1040	0°3	33	67° 57′	55° 30′	35	0°8	56	64° 00′	15° 09′	68	7°57
13	64° 47′	34° 33′	622	3°0	34	65° 17′	54° 17′	55		57	63° 37′	13° 02′	350	3°4
14	64° 45′	35° 05′	176	4°4	35	65° 16′	55° 05′	362	3°6	58	64° 25′	12° 09′	211	0°8
15	66° 18′	25° 59′	330	—0°75	36	61° 50′	56° 21′	1435	1°5	59	65° 00′	11° 16′	310	—0°1
16	65° 43′	26° 58′	250	6°1	37	60° 17′	54° 05′	1715	1°4	60	65° 09′	12° 27′	124	0°9
17	62° 49′	26° 55′	745	3°4	38	59° 12′	51° 05′	1870	1°3	61	65° 03′	13° 06′	55	0°4
18	61° 44′	30° 29′	1135	3°0	39	62° 00′	22° 38′	865	2°9	62	63° 18′	19° 12′	72	7°92
19	60° 29′	34° 14′	1566	2°4	40	62° 00′	21° 36′	845	3°3	63	62° 40′	19° 05′	800	4°0
20	58° 20′	40° 48′	1695	1°5	41	61° 39′	17° 10′	1245	2°0	64	62° 06′	19° 00′	1041	3°1
21	58° 01′	44° 45′	1330	2°4	42	61° 41′	10° 17′	625	0°4	65	61° 33′	19 00′	1089	3°0
22	58° 10′	48° 25′	1845	1°4	43	61° 42′	10° 11′	645	0°05	66	61° 33′	20° 43′	1128	3°3
23	60° 43′	56° 00′	Only the Plankton-Net used		44	61° 42′	9° 36′	545	4°8	67	61° 30′	22° 30′	975	3°0

Station Nr.	Long. W.	Lat. N.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
68	62° 06′	22° 30′	843	3°4	92	64° 44′	32° 52′	976	1°4	118	68° 27′	8° 20′	1060	—1°0
69	62° 40′	22° 17′	589	3°9	93	64° 24′	35° 14′	767	1°46	119	67° 53′	10° 19′	1010	—1°0
70	63° 09′	22° 05′	134	7°0	94	64° 56′	36° 19′	204	4°1	120	67° 29′	11° 32′	885	—1°0
71	63° 46′	22° 03′	46			65° 31′	30° 45′	213		121	66° 59′	13° 11′	529	—0°7
72	63° 12′	23° 04′	197	6°7	95	65° 14′	30° 39′	752	2°1	122	66° 42′	14° 44′	115	1°8
73	62° 58′	23° 28′	486	5°5	96	65° 24′	29° 00′	735	1°2	123	66° 52′	15° 40′	145	2°0
74	62° 17′	24° 36′	695	4°2	97	65° 28′	27° 39′	450	5°5	124	67° 40′	15° 40′	495	—0°6
	61° 57′	25° 35′	761		98	65° 38′	26° 27′	138	5°9	125	68° 08′	16° 02′	729	—0°8
	61° 28′	25° 06′	829		99	66° 13′	25° 53′	187	6°1	126	67° 19′	15° 52′	293	—0°5
75	61° 28′	26° 25′	780	4°3	100	66° 23′	14° 02′	59	0°4	127	66° 33′	20° 05′	44	5°6
76	60° 50′	26° 50′	806	4°1	101	66° 23′	12° 05′	537	—0°7	128	66° 50′	20° 02′	194	0°6
77	60° 10′	26° 59′	951	3°6	102	66° 23′	10° 26′	750	—0°9	129	66° 35′	23° 47′	117	6°5
78	60° 37′	27° 52′	799	4°5	103	66° 23′	8° 52′	579	—0°6	130	63° 00′	20° 40′	338	6°55
79	60° 52′	28° 58′	653	4°4	104	66° 23′	7° 25′	957	—1°1	131	63° 00′	19° 09′	698	4°7
80	61° 02′	29° 32′	935	4°0	105	65° 34′	7° 31′	762	—0°8	132	63° 00′	17° 04′	747	4°6
81	61° 44′	27° 00′	485	6°1	106	65° 34′	8° 54′	447	—0°6	133	63° 14′	11° 24′	230	2°2
82	61° 55′	27° 28′	824	4°1		65° 29′	8° 40′	466		134	62° 34′	10° 26′	299	4°1
83	62° 25′	28° 30′	912	3°5	107	65° 33′	10° 28′	492	—0°3	135	62° 48′	9° 48′	270	0°4
	62° 36′	26° 01′	472		108	65° 30′	12° 00′	97	1°1	136	63° 01′	9° 11′	256	4°8
	62° 36′	25° 30′	401		109	65° 29′	13° 25′	38	1°5	137	63° 14′	8° 31′	297	—0°6
84	62° 58′	25° 24′	633	4°8	110	66° 44′	11° 33′	781	—0°8	138	63° 26′	7° 56′	471	—0°6
85	63° 21′	25° 21′	170		111	67° 14′	8° 48′	860	—0°9	139	63° 36′	7° 30′	702	—0°6
86	65° 03′.6	23° 47′.6	76		112	67° 57′	6° 44′	1267	—1°1	140	63° 29′	6° 57′	780	—0°9
87	65° 02′.3	23° 56′.2	110		113	69° 31′	7° 06′	1309	—1°0	141	63° 22′	6° 58′	679	—0°6
88	64° 58′	24° 25′	76	6°9	114	70° 36′	7° 29′	773	—1°0	142	63° 07′	7° 05′	587	—0°6
89	64° 45′	27° 20′	310	8°4	115	70° 50′	8° 29′	86	0°1	143	62° 58′	7° 09′	388	—0°4
90	64° 45′	29° 06′	568	4°4	116	70° 05′	8° 26′	371	—0°4	144	62° 49′	7° 12′	276	1°6
91	64° 44′	31° 00′	1236	3°1	117	69° 13′	8° 23′	1003	—1°0					

Ingolf Expeditionen 1895 & 1896.